

GUIDED INQUIRY LEARNING USING PHET SIMULATIONS BASED WORKSHEET TO IMPROVE STUDENTS' CONCEPTUAL UNDERSTANDING ON KINETIC THEORY OF GASSES.

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Abstract

The purpose of this study is to describe the improvement of students' concept understanding after the guided inquiry learning using PhET Simulations based worksheet. This type of research is pre-experimental with One Group Pretest-Posttest design. The subject of the research is the XI Science 1 and XI Science 2 Class of Al Falah Islamic School in Surabaya. This research only use experimental class without comparison class (control) to find out the results of the research do not happen by accident. The normality and homogeneity test showed that the sample used in this research are from the normal and homogenous population. The improvement of students conceptual understanding is analyzed by using paired t-test and normalized gain test. The paired t test results indicate that there is a difference in the results of students' improvement after the learning. The improvement of students conceptual understanding improved pretty well with the score of 0,60 for XI Science 1 and the score of 0,65 for XI Science 2. The improvement also occurs for all indicators of understanding i.e. Interpreting, Comparing, Classifying, Summarizing, Exemplifying, Explaining, and Inferring. Based on the results of the research, it can be concluded that the guided inquiry learning using PhET Simulations based worksheet is able to improve the concept understanding of students.

Password: guided inquiry, worksheet, PhET Simulations, conceptual understanding.

INTRODUCTION

Getting an education is a right for every individual. By acquiring education, communities will be able to develop their potential to face the era of progress rapidly. To realize the goal, the qualified and effective education is needed. Education is said to be qualified and effective when students have been able to master the material presented by the teacher according to expectations. As has been explained in the Government Regulation No. 20 Year 2003 of the national education system, article 3, that "the function of national education is to develop the ability to form character and the civilization of the people dignity in order to improve the intellectual life of the nation, aimed to develop the potential of the students in order to become a man of faith and piety to God Almighty, precious, healthy, have learned, accomplished, creative, independent, and become citizens of a democratic and responsible".

Based on pre-research done against 20 high school students of Al Falah Islamic, shows about 95% of students find it easier to understand the concept of physics through experiment. The experiment done by students of Al Falah Islamic School is a real experiment in the laboratory. Some of the physics material consists of microscopic objects that are difficult to be directly observed. One of that is the kinetic theory of gases matter. A number of student samples from 20 people, 100% answered never carry out an experiment work on kinetic theory of gasses. By not ensuring the practical work in school, students feel that understanding they get it less. The physics learning at

school, teachers tend to just explain and students listen. This indicates that the level of activity of students during the learning is a lot less.

The model used of learning in school affects the level of activity and understanding of students. To improve the activity and understanding, an appropriate learning model need to be used. One of the learning models that believed to be able to improve the activity of students in learning is guided inquiry learning. The same thought is presented by Markaban (2008) that guided inquiry learning model has advantages i.e. students will partake in active learning and instill active properties to search and find. With the enthusiastic students in learning, will support the ability in solving problems and discovering the concept independently.

Educational facilities include a learning resource and infrastructure support, as well as the use of technologies that support the learning process. The use of learning resources is intended to facilitate the process of learning (Mulyasa, 2006). According to Sayekti, *et al* (2012), the process of learning through experiment can be done using real or virtual lab laboratory. Real laboratory is a place used for conducting investigations that are equipped with the tools and materials to support the experiment. But not all the matter in physics can be observed through real laboratory activities. Some abstract concepts in physics requires media to be observed. Basically the lab activities can be implemented using virtual lab that serves a variety of simulations. The use of the virtual lab can be done in the classroom so that it does not take a long time. In this research, researchers using PhET Interactive Simulations.

PhET (Physics Education Technology) is an interactive simulation that contains physical phenomena-driven research that is already adapted to the actual circumstances. By combining the results of the study will allow students to connect real-life phenomena and the science underlying the phenomena. The simulation presented is possible to improve the understanding and interest of students in learning physics.

Based on the above explanation, researchers are interested in conducting research of guided inquiry learning using PhET Simulations worksheet to improve students; conceptual understanding on kinetic theory of gasses. Based on the research that has been conducted by Rohaniyah (2017) under the title "Learning Using Virtual Labs and Real Laboratory to improve the competence of Students in Boyle's law-Gay Lussac's law and the Ideal Gas Equation" that study used the Virtual Lab PhET on the kinetic theory of gases categorized as very well.

Based on the above description, researchers will conduct research under the title "Guided Inquiry Learning Using PhET Simulations Based Worksheet to Improve Students' Conceptual understanding on Kinetic Theory of Gasses"

METHOD

This study used a pre-experimental type with One Group Pretest-Posttest Design. In this study aims to examine the effect of treatment on a group so that in this study only use one class of experiments and one class of replication without using a control class (control). The use of replication class aims to have the results of research have the power and not obtained by chance. The treatment given in this research is guided inquiry learning using LKS based on PhET Simulations. The study design is illustrated as follows :

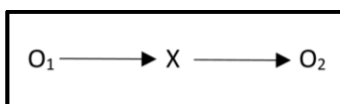


Figure 1. Research Design

Explanation:

- O_i : pretest done before implementing the guided inquiry learning.
- X : a treatment using guided inquiry learning.
- O_a : posttest done after implementing the guided inquiry learning

Research subjects to be used are experimental and replication classes that received equal treatment in learning.

Table 1. Research Design

Class	Pre-test	Treatment	Post-test
Experiment	O_i	X	O_a
Replication	O_i	X	O_a

The subjects of this study are the students of class XI Science 1 and XI Science 2 Al Falah Islamic School. Subjects of the study based on the class group provided by physics teachers with the same academic characteristics.

The process of taking data using observation methods, tests, and questionnaires. Observation is used to determine the implementation of learning by teachers. The test is used to analyze the results of improving conceptual understanding using the pretest and posttest sheets. Questionnaires are used to find out the students' responses after learning.

RESULT AND DISCUSSION

Result

Instruments about 15 items of questions tested on 22 students of class XII of Al Falah Islamic School. The test questions were carried out to obtain a feasible question for the pre-test and post-test sheets. To get a feasible problem, the test results are analyzed through 3 criteria, namely the level of difficulty, validity, and reliability.

Based on the test level of difficulty, validity, and reliability, of the 15 questions obtained 12 questions that meet the three criteria.

The results of pretest and posttest analyzes were tested for its normality and homogeneity. In the normality test for pretest obtained a value χ^2_{count} of 4.002 in the experimental class and amounted to 4.188 in the replication class. With a value χ^2_{table} of 9.49. While the posttest normality test obtained value χ^2_{count} of 2.142 in the experimental class and amounted to 2.943 in the replication class. With a value χ^2_{table} of 9.49. Homogeneity test for pretest obtained value χ^2_{count} equal to 0,09 and for posttest equal to 0,391. With a value χ^2_{table} of 3.84. From the analysis results can be concluded that the sample used comes from the population of normal and homogeneous distribution with a significant level $\alpha = 0.05$ because the value of $\chi^2_{count} \leq \chi^2_{table}$.

In this study the pretest value is used to determine the students' initial ability before being given the lesson. While the value of posttest is used to find out the final result of student value after given learning.

Based on pretest and posttest result, t test analysis is used to know the significance of the improvement of student learning outcomes after the implementation of guided inquiry learning using PhET Simulations based worksheet, the results of t-pair t test calculations are presented in Table 2.

Table 2. The Calculation of Paired T-Test Analysis

No.	Class	$t_{\text{calculation}}$	t_{table}
1	Experiment	12,47	2,00
2	Replication	12,15	2,00

Based on Table 1, it is known that in both classes the value of $t_{\text{count}} \geq t_{\text{table}}$, so H_0 is rejected. From the analysis it can be concluded that there are significant differences in values between the two classes between before and after guided inquiry learning using PhET Simulations based worksheet.

To describe how big the increase is, it is calculated using a normalized gain score. Normalized gain test results are presented in Table 3 below:

Table 3. The Result of Normalized Gain Score

No.	Class	$\langle g \rangle$	Category
1	Experiment	0,60	Medium
2	Replication	0,65	Medium

From these results it is known that normalized gain scores in both classes have increased. In the replication class the normalized gain is higher than the experimental class.

Conceptual understanding consists of several indicators. According to Anderson (2001), understanding indicators include Interpreting, Exemplifying, Classifying, Summarizing, Inferring, Comparing, and Explaining. An analysis of conceptual understanding improvement in the experimental class for each indicator is presented in Table 4 below:

Table 4. Result of Understanding Indicator Analysis in Experiment Class.

No.	Indicator	Gain
1	Interpreting	19%
2	Explaining	11%
3	Comparing	55%
4	Classifying	27%
5	Summarizing	36%
6	Exemplifying	32%
7	Inferring	50%

While the result of improvement analysis of conceptual understanding in replication class for each indicator is presented in Table 5 below:

Table 5. Result of Understanding Indicator Analysis in Replication Class.

No.	Indikator	Peningkatan
1	Interpreting	16%
2	Explaining	14%
3	Comparing	48%
4	Classifying	47%
5	Summarizing	42%
6	Exemplifying	78%
7	Inferring	16%

Based on Table 4 and Table 5, each indicator experienced a different percentage of improvement. In the table there are 3 indicators that have a considerable increase in the difference between the experimental class and the replication class, i.e. on the indicators of classifying, exemplifying, and inferring.

Discussion

Pre-test is used to determine the students' early ability before being given guided inquiry learning on the kinetic gas theory material. The mean pre-test values for the experimental and replication classes are 36 and 37 respectively.

Assessment of knowledge competence is obtained through post-test results. Post-test is given after the students get guided inquiry learning using LKS based on PhET Simulations on kinetic gas theory material. The students' ability to receive and understand the material of kinetic gas theory varies by using guided inquiry learning model. This can be seen through the average post-test results for the experimental and replication classes of 74 and 78 respectively.

The students' pre-test and post-test scores were used for the t-test to determine whether there was an increase in student learning outcomes or not. Based on Table 2 it is known that $t_{\text{count}} > t_{\text{table}}$ so H_0 is rejected and H_1 is accepted for both classes. So it can be concluded that guided inquiry learning using PhET Simulations based worksheet can improve students' concept understanding significantly. This is supported by research conducted by Musdar (2015) which shows that the results of inquiry in guided based virtual labs have increased despite low categorization. Theoretically, guided inquiry learning is supported by several theories of learning, one of which is Bruner's Theory of Discovery which states that when the students try their own in searching for problem solving on a problem, it will produce knowledge that is really meaningful (Dahar, 2011)

Furthermore the normalized gain test is done to find out how big the increase in understanding the concept of students. Based on Table 3 it is known that there is an increase in student learning outcomes in both classes. In

the experimental class obtained a normalized gain value of 0.60 medium category. As for the replication class obtained a normalized gain value of 0.65 moderate category. In the experimental class obtained a normalized gain lower than the replication class. This can happen because the student response score on the experimental class is lower than the replication class.

Based on the results of the normalized gain analysis, the two classes experienced an increase in concept comprehension although still in the medium category. Increased understanding of student concepts in the research seen on each indicator. In the Interpreting indicator, in the experimental class obtained an increase of 19% and in the replication class of 16%. In the learning process, interpreting indicator occurs in the phase of analyze and interpret data. From the explanation, it shows that students' ability to change information from one form to another has increased. In the Explaining indicator, the experimental class showed an 11% improvement and the replication class was 14%. In the learning process, explaining indicators occur in the given phenomenon and application phases. From the explanation, it shows that students' ability in constructing and explaining through causal model has increased. In the Comparing indicator, in the experimental class, there was an increase of 55% and in the replication class by 48%. In the learning process, the comparing indicator occurs in the application phase. From the explanation, shows that the ability of students to find similarities or differences between two or more objects has increased. In the Classifying indicator, in the experimental class obtained an increase of 27% and in the replication class of 47%. In the learning process, classifying indicators occur in the phase of analyze and interpret data. Learning outcomes in phase 3 (aspects of guiding students in processing and analyzing data) in the experimental class showed a score of 3.25. While in the replication class showed a score of 4. This is what causes increased understanding of Classifying indicators in the replication class is higher than in the experimental class. Because the role of teachers in guiding students in processing and analyzing data in the experimental class is considered not as good as in the replication class. From the explanation, shows that the ability of students to recognize something by special category has increased. In the Summarizing indicator, the experimental class showed an increase of 36% and in the replication class by 42%. In learning, the summarizing indicator occurs in the review phase. From the explanation, shows that the ability of students in representing information in the form of a summary of themes has increased. In the Exemplifying indicator, in the experimental class obtained an increase of 32% and in the replication class of 78%. In learning, the exemplifying indicator occurs in the application phase.

There is a considerable difference between the experimental and replication classes. The results of the analysis of students' answers to the worksheet for the exemplifying aspect, in the experimental class of several groups of students are only able to give 1 example of another relevant phenomenon. While in the replication class, the results of the analysis of the worksheet answers to the exemplifying aspects, almost all groups of students are able to provide some examples of other relevant phenomena. This has an effect on the improvement of conceptual understanding on the exemplifying indicator, which increases in the replication class is higher. From the explanation, indicate that the student has been able to give a specific example of a concept. Inferring indicators, in the experimental class obtained an increase of 50% and in the replication class of 16%. In learning, inferring indicators occur in the formulate hypotheses and data gathering phases. Learning outcomes in phase 2 (aspects of guidance on students to formulate problems and hypotheses) in the experimental class showed scores of 3.25 and in the replication class of 3. This became one of the factors of increasing understanding of the inferring indicators in the experimental class higher than the class replication. The role of teachers in guiding students to formulate hypotheses in the replication class is judged lower than the experimental class. From the explanation, indicate that the student has been able to find the pattern in a series of examples presented.

From the above discussion can be concluded that the implementation of guided inquiry learning using PhET Simulations based worksheet can improve student learning outcomes on the material kinetic theory of gas.

CONCLUSION

Improved learning outcomes with conceptual understanding indicator on the Kinetic Theory of Gasses after applied guided inquiry learning using PhET Simulations based worksheet on Material Gas Kinetic Theory in experiment class of 0.60 with medium category and in replication class of 0.65 with medium category. Significant improvements occur in all classes used as research subjects. From the discussion shows that there is consistency of improvement of learning outcomes in the conceptual understanding indicator after applied guided inquiry learning using PhET Simulations based worksheet.

SUGGESTION

Based on the research and analysis of the results of research conducted, the researchers provide suggestions for further research that will be done can run better. Suggestion given is in this research using virtual lab media that is PhET Simulations software, so it's good at the previous meeting have prepared in laptop which will be

used for experiment. Prior to learning, teachers should provide direction to students about learning strategies that will be done and prepare learning media such as LCD, Power point presentation, and PhET Simulations for effective learning time.

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