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PHYSICS LEARNING USING REAL AND VIRTUAL LABORATORY ACTIVITES TO IMPROVE STUDENT COMPETENCIES IN BOYLE-GAY LUSSACS LAW AND IDEAL GASES EQUATION

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Abstract

The aim of this research is to describe the implementation of learning, improvement of competence, and student's response toward physics learning using real and virtual laboratory in Boyle-Gay Lussac's Law and ideal gases equation. Improved competencies include knowledge and skills. The type of research was used pre-experimental with one-group pretest-posttest design by using three experimental classes. The subjects of the study were students of class XI IPA 1, XI IPA 2, and XI IPA 3 in SMAN 4 Sidoarjo. Instruments used are observation sheet of learning implementation, pretest posttest of knowledge and skill, process skill assessment sheets, and student response questionnaire. Increased student competence was analyzed by paired t-test and gain score analysis. The results showed that (1) the implementation of learning was done very well; (2) students' knowledge and skill competitiveness increased significantly in high category; (3) student's response to learning through real and virtual laboratory activities got good category.

Key words: real laboratory, virtual laboratory, Boyle-Gay Lussac's Law and ideal gases equation.

INTRODUCTION

Curriculum 2013 is a curriculum designed to develop students' potentials to suit national education objectives. In realizing these objectives, students are expected to have generic competencies that include three domains of attitude, knowledge, and skill competencies.

One of the physics materials at high school level is learning about the kinetic theory of gas. Basic competence in the material of gas kinetic theory requires students to understand the kinetic theory of gas and the characteristics of the gas in the enclosed space and to present the thought-provoking report on the gas kinetic theory and its physical meanings. As an effort to achieve these competencies, laboratory-based learning activities are needed.

Based on the results of interviews at SMAN 4 Sidoarjo, physics teacher stated that during this process of learning on kinetic theory of gas especially sub material Boyle-Gay Lussac's Law and gas situation equation has never been done through laboratory activities. This indicates that the learning process in the material has not been in accordance with the principles of the Curriculum 2013. The trust of the Curriculum 2013 states that the product or knowledge on the material of physics should be obtained through a procedure or scientific investigation (Permendikbud No. 59 of 2014). Such scientific procedures or investigations may be obtained through laboratory activities.

Godwin et al (2015) revealed that through laboratory activities students become more active in building knowledge so that learning becomes more meaningful. The active learning process, can help students to instill physical knowledge permanently (Azar and Sengulec, 2011). It is clear that laboratory activities are needed to support the learning process in schools.

The necessity of laboratory activities in the Boyle-Gay Lussac's Law and ideal gas equations material is supported by the results of the pre-research questionnaire. As many as 93.10% of students, the existence of student laboratory activities becomes easier in understanding learning materials and can trained the skills. A total of 81.67% of students also stated that laboratory activities are required on the Boyle-Gay Lussac's Law and ideal gas equations material.

The Boyle-Gay Lussac Law Sub-article and the ideal gas equation are subject to abstract gas particles. Some parts of the material can be modeled through the real laboratory, but there are parts that cannot be modeled through the real laboratory, thus requiring virtual labs to model them.

Real laboratory activities use simple props to explain the relationship between variables in Boyle's law and Charles's law. This real laboratory adopted from Blanco

and Romero (1995). The virtual lab activities used in this study are PhET Simulation to explain Gay-Lussac Law and ideal gas equations. In PhET simulation the object is designed to be very interactive, interesting, as well as presenting the visualization model according to the physics principle (Finkelstein et al, 2005).

The results of research conducted by Alkhalifa (2005), Bayrak et al (2007), Kuei-Pin Chien et al (2015), and Fachruddin and Supriyono (2015) indicate that there is no significant difference between students who perform laboratory activities through the laboratory real or virtual labs. Both types of laboratory activities can be used as effective learning strategies to create meaningful learning (Zacharias, 2007). In addition, they can also shape students' scientific attitudes, instill conceptual understanding, and improve investigation skills (de Jong et al, 2013).

Based on the explanation above, it shows that in obtaining knowledge on the Boyle-Gay Lussac Law sub-material and ideal gas equation required an innovation of laboratory activities that can support for the learning process. Following this, a research entitled "Physics Learning using Real and Virtual Laboratory Activities to Improve Student Competencies in Boyle-Gay Lussac's Law and Ideal Gas Equation" with the aim to describe the implementation of learning, improvement of competence, and student's response to learning through real and virtual laboratory activities.

METHOD

This research uses pre-experimental with one-group pretest-posttest design. The subjects of the study were students of grade XI IPA in SMAN 4 Sidoarjo. The study used three experimental classes with the aim of comparing the outcomes of each class to obtain the right conclusions.

Aspects that are measured include the implementation of learning, improvement of competence, and student responses. The method used is observation for learning implementation and student performance skills; test methods for competence; questionnaire method for student's response toward the learning.

Competencies consist of attitudes, knowledge, and skills, but competence of attitude is difficult to assess, so the competency assessment only includes knowledge and skills. Increased competence of knowledge and skills is obtained through pretest and posttest. Skill competencies are supported from the students' process skills in terms of formulating problems, formulating hypotheses, defining variables, presenting data, analyzing, and concluding on each laboratory activity.

Increased competence is analyzed through paired t-test and gain score analysis, while the learning implementation and response are analyzed by calculating the acquisition score.

RESULT AND DISCUSSION

Learning implementation is observed by three people and given a score in each activity. The activities include preliminary, core, and closing activity. The learning implementation is showed as follows

Table 1 Learning Implementation Result

No	Aspect	Score (%)					
		XI IPA 1		XI IPA 2		XI IPA 3	
		1	2	1	2	1	2
1	Preliminary	85	94	77	85	81	83
2	Observing	92	92	83	92	83	92
3	Questioning	71	79	75	88	71	79
4	Data Collecting	86	92	86	97	83	89
5	Associating	75	83	71	83	75	88
6	Communicating	77	81	71	81	77	85
7	closing	75	83	75	92	83	92
8	Time Allocation	72	78	72	89	81	86
Average each Meeting		79	85	76	88	79	86
Average each Class		82		82		83	

Based on the table above, learning implementation in three classes has improving from first meeting to second meeting. It is caused the constraints that occurred during the first meeting can be overcome during the second meeting. Although there are obstacles, but overall the implementation of learning is considered very good with the details of class XI IPA 1 and XI IPA 2 get score 82%, and class XI IPA 3 get score 83%.

Knowledge Competence

The improvement of students' knowledge competence is obtained from pretest and posttest values then tested by paired t test and gain score analysis. The paired t test result is showed as follows

Table 2 Paired t test of Knowledge Competence

No	Class	t_{count}	t_{table}	Conclusion
1	XI IPA 1	15,60		The average
2	XI IPA 2	23,89	1,70	gain is
3	XI IPA 3	17,91		significant

Based on paired t test, it was found that the mean of gain obtained from students' pretest and posttest values increased significantly. This shows that there is a significant increase of students' knowledge competence after using real and virtual laboratory activities in learning

The category of improvement in students' knowledge competence can be analyzed by a normalized gain score analysis. The results are presented below

Table 3 Gain Score Analysis of Knowledge Competence

No	Class	N <g>	Category
1	XI IPA 1	0,695	Medium
2	XI IPA 2	0,730	High
3	XI IPA 3	0,760	High

Table 3 above shows that the gain score analysis of the three classes is different. Both classes have a high category and the one class is medium, so it can be categorized that the gain score rate obtains a high category for knowledge competence.

Increased student competence is not independent of learning activities through a scientific approach to laboratory activities. This is because the activities of the laboratory can understand, deepen, and comprehend knowledge (Amien, 1988), while learning through scientific approach can foster the ability to think and be scientific (Vanaja and Rao, 2006). Therefore, learning using laboratory activities and scientific approaches can help deepen the thinking ability that affects the students' knowledge.

Skill Competence

The results of research on skill aspects are shown as follows

Table 4 Paired t test of Skill Competence

No	Class	t_{count}	t_{table}	Conclusion
1	XI IPA 1	24,00		The average
2	XI IPA 2	17,89	1,70	gain is
3	XI IPA 3	18,98		significant

Based on the above table shows that there is a significant increase in student skill competence after going through the learning process through real and virtual laboratory activities.

The improvement score of the pretest to postest is obtained through a normalized gain score analysis. Based on the analysis obtained the following results

Table 5 Gain Score Analysis of Skill Competence

No	Class	N <g>	Category
1	XI IPA 1	0,755	High
2	XI IPA 2	0,706	High
3	XI IPA 3	0,757	High

These results indicate that gain score average obtains a high category for skill competence, so it can be concluded that the competence of skills increased significantly with high category

This is because when students perform laboratory activities, students maximize all senses to obtain data. When optimizing all senses, students demonstrate active and independent engagement during learning so as to produce meaningful learning (Godwin et al, 2015).

Based on the exposure of improvement in knowledge and skill competence, it is showed that the real and virtual laboratory activities on the Boyle-Gay Lussac's Law and ideal gas equation can improve the competence of knowledge and skills significantly in the high category. Laboratory activities are an effective means of creating meaningful learning so as to cultivate thinking skills (Olufunke, 2012), shaping scientific attitudes, instilling conceptual understanding, and enhancing investigative skills (de Jong et al, 2013). Therefore, learning through laboratory activities with a scientific approach can foster scientific attitudes, ability to think (knowledge), and skills that affect student learning outcomes.

Students Respon

The student response consists of 13 statements. The results of the student responses are showed as follows

Table 5 Score of Student Response

No	Statements	Score (%)		
		XI IPA 1	XI IPA 2	XI IPA 3
1	The learning process can stimulate my knowledge	81	82	77
2	The phenomenon of illustration presented caught my attention	82	84	84
3	The phenomenon which was presented improved my curiosity	83	85	86
4	The teaching process allows me to dig information	78	81	78
5	The teaching process makes easy to understand the material	78	78	76
6	The teaching process allows me to find concepts	81	78	74
7	The teaching process makes easy to connect the concept with everyday life	77	79	76
8	Learning using real and virtual laboratory activities in Boyle-Gay Lussac's Law and ideal gas equations help me be more skilled in experimenting	80	83	78
9	Learning using real and virtual laboratory activities in Boyle-Gay Lussac's Law and ideal gas equations make me easier in solving problems	77	82	73

No	Statements	Score (%)		
		XI IPA 1	XI IPA 2	XI IPA 3
10	Learning using real and virtual laboratory activities in Boyle-Gay Lussac's Law and ideal gas equations are not boring	79	80	80
11	I am pleased to learn using real and virtual laboratory activities in Boyle-Gay Lussac's Law and ideal gas equations	80	81	80
12	I like to learn using real and virtual laboratory activities in Boyle-Gay Lussac's Law and ideal gas equations	79	82	82
13	I agree if learning using real and virtual laboratories is applied to other materials	81	84	85
	Score each Class	80	82	79
	Category	Good	Very Good	Good

The results above show that the two classes get good category and one grade gets very good category, so it can be concluded the student's response to learning gets the good category.

According to the questionnaire results, students recommend that learning using real and virtual laboratory activities can be applied to other materials with a score of 83.50% is categorized very well. This suggests that learning strategies using real and virtual laboratory activities need to be applied to other materials to improve the competence of students especially knowledge and skills.

CLOSING

Conclusion

Based on the results and discussions that have been reviewed then the conclusions can be taken are:

1. Implementation of learning using real and virtual laboratory activities in Boyle-Gay Lussac's Law and ideal gas equations is done very well.
2. Knowledge and skill competencies are increased significantly with the acquisition of high category
3. Student response to learning through real and virtual laboratory activities get good categorized scores.

Suggestion

Based on the research, the researcher suggested that learning using real and virtual laboratory activities should be done on other material to improve a better competence on the knowledge and skills aspect. When the learning process using laboratory activities occur, it required setting the right time for the learning activities to go according to plan.

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