Learning buffer solution based on virtual lab in senior high school

Gulmah Sugiharti[1],* and Aldhi Kurnia[1]

[1]Department of Chemistry, Universitas Negeri Medan, Medan 20221, Indonesia
*Corresponding author: GS, sugihartigulmah@gmail.com

Abstract: This study aims to determine whether there is a difference between the use of virtual lab and real lab media in guided inquiry learning on learning outcomes in the buffer solution material. Both learning media are taught using the same learning model, namely the guided inquiry learning model. The samples in this study were class XI MIPA 3 as the experimental I which was taught with the guided inquiry learning model using virtual lab media and class XI MIPA 6 as the experimental II which was taught by guided inquiry learning model using real lab. The instrument used in this research was a test of learning outcomes chemistry of the buffer solution material. The data analysis technique for hypothesis testing was the two-party t-test statistic. The results of data processing showed that the experimental I had a pretest mean of 26.04 and a mean of posttest 79.53, while the experimental II had a mean pretest of 47.95 and a mean of posttest of 72.84. Hypothesis testing was carried out using two-party t test from the learning outcomes data and it was obtained t_{count} = 2.201 while t_{table} = 1.988 for α = 0.05 so that $t_{count} > t_{table}$. So Ha accept, that is, there are differences in student learning outcomes taught by guided inquiry models using virtual lab and real lab media. Meanwhile, the increase in student learning outcomes in guided inquiry classes using virtual labs was 72%, and those using real labs were 52%.

Keywords: Virtual lab, Real lab, Guided inquiry, Buffer solutions

1. Introduction

Chemistry lessons in high school contain many concepts that are quite difficult for students to understand, because they involve chemical reactions, calculations and many involve abstract concepts. Buffer solution is one of the materials that are considered difficult and abstract (Asnaini, 2017). The low learning outcomes of chemistry, especially in the buffer solution material in MAN 1 Medan requires a learning innovation, including the learning model.

One of the learning models that can be used in the 2013 Curriculum is to use a guided inquiry learning model. Guided inquiry learning can direct students to solve

given problems by connecting or applying their chemical knowledge to improve critical thinking skills and student learning activities (Subhan et al. 2018). Bilgin (2009) reported that the guided inquiry learning model is a learning model in which the teacher integrates a scientific activity and builds students' thought patterns simultaneously based on facts, principles and acceptable scientific rules.

Guided inquiry learning can develop students 'cognitive abilities, students' ability to communicate, develop scientific attitudes, increase student interest and student learning outcomes (Kristianto and Susilo, 2016). Meanwhile, (Nworgu and Otum, 2013), Guided inquiry can help students to gradually get used to thinking scientifically. The same thing was stated by (Moore et al. 2013) which stated that guided inquiry learning is very suitable to be applied to teach students to think scientifically. Meanwhile Sugiharti and Hasibuan (2017) concluded that there was an effect of the Inquiry learning model using real laboratories and virtual laboratories on student learning outcomes on reaction rate material.

Chemistry learning includes the ability to think at three levels: macroscopic, symbolic, and particle level (Johnstone, 1991). When studying chemistry, it is important to understand and know how to relate concepts to the three levels (macroscopic, symbolic and sub-microscopic), which is difficult for many people. The gap between the levels of visualization can generally be overcome by the use of visualizations such as virtual media (Barke and Wirbs, 2002). Virtual Laboratory is a laboratory where simulations are used here to display the experimental process. It can be concluded that learning using a Virtual Laboratory has several advantages, namely (a) Increasing students' mastery of concepts; (b) Improve creative thinking skills and scientific problem solving; (c) Develop skills in the field of ICT without neglecting knowledge of laboratories (Hermansyah et al. 2015).

Virtual laboratory is an interactive multimedia object. Interactive multimedia objects consist of a variety of heterogeneous formats including text, hypertext, sound, images, animation, video, and graphics. In general, virtual laboratories, such as simulations, are intended to transfer both conceptual and procedural knowledge (Ekasari et al. 2016). While the real lab is in the form of practicum activities in the laboratory. This study aims to determine whether there are differences in the use of virtual lab and real lab media in guided inquiry learning on learning outcomes in the buffer solution material.

Research (Sugiharti and Limbong, 2018) it can be concluded that there are students who have high learning motivation using virtual labs give a higher mean, while students who have low learning motivation using virtual labs give low average learning outcomes. But Pambudi et al. (2015) found no difference in learning outcomes using virtual labs and real labs, this happens because both the real lab and virtual lab both help students build knowledge structures so that the use of both provides relatively the same learning achievement. The real lab provides real experiences for students through the use of their minds and senses to observe and

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conclude experimental results, while the virtual lab will improve the quality of the experiment, because it allows students to experiment repeatedly to clarify the doubts that exist within them.

2. Methods

This research was conducted at MAN 1 Medan on the buffer solution material. The design of this research is posttest group design, namely the experimental class I design and the experimental class II are given a test of understanding concepts and science process skills after different learning models are applied (Sudjana, 2005). The population used in the study was students of class XI MIPA MAN 1 Medan. XI MIPA 3 as an experimental class I which was taught with a guided inquiry learning model using virtual lab media and as an experimental class II which was taught with a guided inquiry learning model using a real lab.

The data collection technique in this research is the evaluation of learning outcomes in the form of pre-test and post-test. The test form for pre-test and post-test evaluation is a multiple choice objective form for experimental class I and experiment II. The pre-test and post-test questions given to the experimental class I and experiment II are the same. Before the test is used as a data collection tool, the validity, reliability, level of difficulty, differentiation and distraction are tested.

The research hypothesis was tested by two-party t test (two tail test) at a significant level α = 0.05 degrees of freedom (dk) = n1 + n2 - 2 and probability (1-½ α) using the formula (Silitonga, 2011):

$$t_{cal} = \frac{(\overline{X}_1 - \overline{X}_2) - do}{sp\sqrt{(1/n_1) + (1/n_2)}}$$

$$SP = \sqrt{\frac{(n_1-1)s_1{}^2 + (n_2-1)s_2{}^2}{n_1 + n_2 - 2}}$$

Information:
n1 ≠ n2
σ1 = σ2 (homogenous)
So:
db = $n_1 + n_2 - 2$

3. Results and Discussion

Data analysis includes normality test, homogeneity test and hypothesis testing. The results of the pretest and posttest analysis have a normal and homogeneous distribution of data. The results of the next analysis are hypothesis testing, the

results of hypothesis testing for the experimental class-I and experiment-II can be seen in Table 1.

Table 1
Hypothesis data analyses

Class	Variable	Analyses	Data		Conclusion
			Manual	SPSS	
Experiment I	Result learning	Mean	79.53	0.035	Accepted Ha
		T test	2.2		
Experiment II	Result learning	Mean	72.48	0.035	Accepted Ha
		T test	2.2		

In the Experimental Class-I column for learning outcomes, the t test is 2.201 where $t_{count} > t_{table}$ is 2.201> 1.988 and sig 0.035. Because the sig. 0.035 <0.05 and tcount> ttable then Ha is accepted or H0 is rejected, which means that the hypothesis is accepted and verified at the level α = 0.05 so it is said that there is a difference in student learning outcomes taught using virtual lab and real lab media, where learning outcomes those taught by applying the Guided Inquiry learning model using virtual lab media are (79.53 ± 13.17), while those taught by applying the Guided Inquiry learning model use the real lab media of their learning outcomes (72.84 ± 15.78). The results also found an increase in normalized gain as in the following Table 2.

Table 2
Average improvement in learning outcomes (gain)

Class	gain Normalized	Information
Experiment I	0.72	High
Experiment II	0.52	Moderate

So the overall % gain for the experimental class I was 72% (high) while for the experimental class 2 it was 52% (moderate). From the description above, it can be concluded that students who are taught using guided inquiry models with virtual lab media experience a higher learning outcome than students taught using guided inquiry models using real lab media.

Various studies on the use of virtual media have also been frequently carried out, such as the results of research by finding that virtual media is effective as a tool to familiarize students with computers or animation. Research (Altun et al. 2009) concluded that providing virtual media is considered a very helpful tool for chemistry teachers and students in high schools especially those who do not have or have limited opportunities to use chemistry laboratories and create experiments .

Correlating with virtual media, research that has been conducted by Tuysuz (2010), concludes that virtual media can effectively improve student learning

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outcomes and have a positive impact on character building students (Harefa et al. 2020; Silaban, 2021; Panggabean et al. 2019). Bilgin research (2009) found that the guided inquiry learning model is a learning model in which the teacher integrates a scientific activity and builds students' thinking patterns simultaneously based on facts, principles and acceptable scientific rules. Meanwhile, (Nuangchalerm, 2014) argues that in inquiry learning, students can explore their skills and abilities and develop intellectual skills and be actively and effectively involved in the scientific process to solve their learning problems.

In connection with the buffer solution material associated with inquiry, (Assriyanto et al. 2014) found guided inquiry learning using virtual labs obtained higher learning outcomes than other models that also used virtual labs on buffer solution material.

4. Conclusion

The results of this study concluded that learning buffer solution material with guided inquiry models was very good using a virtual lab.

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