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Virtual laboratory of protists: Learning media to enhance scientific attitudes

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ABSTRACT

A scientific attitude is important for students to have because scientific attitudes affect the learning process and outcomes. One way to improve scientific attitudes in students is using interactive and interesting learning media. Therefore, this study aims to see the effect of using virtual laboratory media on students's scientific attitudes. The method that used in this study is a quantitative method with a quasi-experimental design. The instrument that used in this study was a scientific attitude questionnaire in the form of a Likert scale. The data were analyzed descriptively and differentially. The research samples used was 70 samples divided into 35 samples in the experimental class and 35 samples in the control class. Based on the results of the study, it was seen that there was an increase in the average value of scientific attitudes in each dimension of scientific attitudes after carrying out learning with virtual laboratory media. It was also known that based on ANCOVA test, the significance value was 0.000<0.05. So, it can be concluded that virtual laboratory media can improve the scientific attitude of students.

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INTRODUCTION

One of the important attitudes to have in science learning is scientific attitude (Hunaepi, 2016). A scientific attitude is a person's view or a person's way of thinking according to scientific methods so that a tendency appears to accept or reject. The scientific attitude is one factor in an individual that affects learning outcomes (Purwaningsih, 2007; Kusuma Rosidin, & Viyanti, 2013). A scientific attitude can determines someone's achievement in completing the learning process (Anderson & Krathwohl, 2001). Students who have a high scientific attitude will have fluency in thinking and always be motivated to excel and have a strong commitment to achieving

success and excellence (Baharudin & Wahyuni, 2007). However, based on several studies that have been conducted previously regarding scientific attitudes in students, it is known that the scientific attitude of students in Indonesia still tends to be low (Sukaesih, 2011; Gani, Safitri, Habibati, & Saminan, 2016).

According to Dimyati & Mudjiono (2004), scientific attitude consists of five dimensions: curiosity, responsibility, discipline, honesty, and conscientiousness, as shown in Table 2. Scientific attitudes in students can be raised through interactive activities that can stimulate flexibility, curiosity, and interest in students's learning, as recommended by Dewey and Fiere (Hunaepi, 2016). Besides, applying a learning model, which at the time of its implementation requires a scientific attitude and scientific skills, for example, with a research practice learning model (Mufida, Sigit, & Ristanto, 2020). This is in accordance with what is required and stated in the curriculum (Suryani, 2016).

One way to improve scientific attitudes in students is by make an innovation of learning media that integrate scientific attitude indicators and contain of scientific activities such as practicum, so that students can learn independently (Damayanti, Ngazizah, & Setyadi, 2013). One of learning media that are believed to improve students's scientific attitudes is virtual laboratory media (Al-Balushi, 2009; Tuysuz, 2010; Tatli & Ayas, 2013). Virtual laboratory media is interactive media that can imitate activities in the laboratory so that users feel currently carrying out practical activities (Wahyuni, 2010; Jaya, 2012).

By using appropriate multimedia in the laboratory (computer simulation), which contains interesting interaction to users especially students, they can learn constructively and enhance their scientific attitude because they become more skilled in solving the problems (Sahin, 2006). Based on the results of a needs analysis on students, it was known that Protists was considered as the most difficult subject matter to understand. Actually, the learning media of Protists has been developed to make students understand about Protists easily such as interactive multimedia, chart media, magazine, monopoly game media, and many more (Rukmana, 2014; Andriyani, 2016; Pratiwi, Gardjito, & Hamidah, 2017) But there are no protists learning media that also can help enhance scientific attitudes. Therefore, the virtual lab media of Protists that has been developed by using scientific attitude indicators was believed can enhance the scientific attitude of students are needed to tested by implemented that media to students.

RESEARCH METHODS

Research Design

The research method used in this study was quasi-experimental with non equivalent control group design. There was an experimental group and a control group and both of groups received a pre test and post test. The experimental group were given a treatment. (Arikunto, 2013). The quasi-experimental design can be seen in Table 1.

Table 1. Quasi-experimental design

Class	Pretest	Treatment	Posttest
Experiment	O_1	Virtual Laboratory	O_2
Control	O_3	Conventional Learning	O_4

Note:
O1, O3 : Pretest
O2, O4 : Posttest

Population and Samples

This research was conducted in the odd semester, on November 2019-March 2020 in SMA Negeri 2 Krakatau Steel, Cilegon. The research sample used was 35 students from the experimental

class and 35 students from the control class. To determined experimental class and control class was selected by a simple group random sampling method. This method was used because the population was considered homogeneous (Sugiyono, 2013). It was proven by the result of the homogeneity test, which has a significance value was 0.872>0.05.

Instruments

The data obtained were the pretest and post-test scores of student's scientific attitudes from experimental class and control class, which was collected through a scientific attitude instrument that was valid and reliable. The instrument has been tested by the expert validators and also has been calculated by used pearson product moment for the validity test and alpha cronbach for the reliability test. The instrument consisted of 45 item statements arranged by the dimension of scientific attitudes (The dimension of scientific attitudes can be seen in Table 2). In each item of the statement, the respondent can choose one of the answers according to their choice, ranging from strongly agree, agree, disagree to disagree strongly.

Table 2. The dimension of scientific attitudes

No	The dimension of Scientific Attitudes	Indicator
1	Curiosity	a. The enthusiasm of students to do a practicum b. The brave attitude of students in asking questions c. A curious attitude in looking for a cause and effect relationship can occur based on experiments and discussions conducted by students
2	Responsibility	a. Students prepare reports in earnest b. Students carry out practicum in accordance with work procedures seriously c. Students feel satisfied if they can carry out practicum as well as possible
3	Discipline	a. Students obey the rules in the laboratory b. Students use time as effectively and efficiently as possible in carrying out practicum c. Students submit reports on time
4	Honesty	a. Students report to the teacher if they make mistakes in carrying out practicum b. Recording actual data according to observations c. Not cheating the results of observations and reports of other students
5	Conscientiousness	a. Students make observations with the senses as needed and gather relevant facts b. Students can use practicum tools and materials properly and correctly c. Students do the experimental steps correctly

Procedures

At first, before started the learning of Protists, the research samples were determined and differentiated into two groups. There were a control group and an experimental group. Both of the experimental and the control group used the same learning method. But they were have a different treatment when did practicum activity. The control group was a class that was not using a virtual-

lab when they were doing a practicum, so they did their practicum by used the conventional laboratory. While the experimental group was a class that was using virtual lab when they were doing a practicum, so the virtual lab was substitute the conventional laboratory. During the practicum activity, the experimental and the control class was accompanied by their biology teacher. The practicum of Protists implemented only once for each class after they learned the theory about Protists.

Before the students learned about Protists and after the students did a practicum of Protists, students in the control and experimental class were asked to answer the scientific attitude instrument to knew their gain score after the learning process. The instrument that was used for pretest and posttest had no differences. Furthermore, the data that has been obtained through scientific attitude instrument was changed into a score. Then the scores were tested for the analysis prerequisite test and hypothesis test. The schematic diagram of the experiment can be seen in Figure 1.

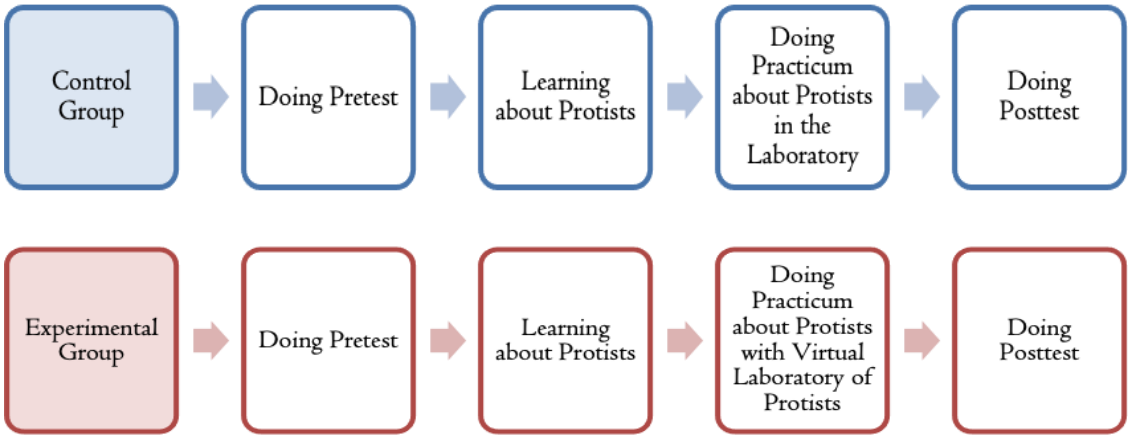

Figure 1. Schematic diagram of the experiment

Data Analysis

The data that has been obtained through scientific attitude instruments was changed into a score. Then the score were analyzed descriptively and differentially by used SPSS software. The descriptive analysis in this study was carried out by presenting frequency tables and histograms. While, for the prerequisite test used was the Kolmogorov-Smirnov test to determine the normality of the data at $\alpha = 0.05$ and the Levene test to determine the homogeneity of data at $\alpha = 0.05$. Based on the result of the normality test carried out on the score of scientific attitudes, the results show that the data is normally distributed, sig>0.05, and based on the result of the homogeneity test carried out on the score of scientific attitudes, the results show that the data was homogenous, sig>0.05. Because the data was normally distributed and homogenous, then to did hypothesis test could using the ANCOVA test to see the effectiveness of using virtual laboratory media at $\alpha = 0.05$. It used ANCOVA because to see the effectiveness of the treatment in the experimental group. Furthermore, ANCOVA test was used to ensure that pretest activity did not affect the score of scientific attitudes, because by using ANCOVA test the variance of other factors outside of the independent variable can be controlled (Putrawan, 2017).

RESULTS

The research result is descriptive statistics on the value of scientific attitudes: minimum scores, maximum scores, total scores, average scores, standard deviation values, and variance in the experimental and control classes (Table 3).

Table 3. Descriptive statistics of the value of scientific attitudes on students (n = 35)

	Min	Max	Total	Average	SD	Variance
Pretest experiment	69.17	80.83	2657.49	75.9283	2.87783	8.282
Posttest experiment	75.00	82.50	2756.67	78.7620	2.28998	5.244
Pretest control	69.17	80.00	2600.00	74.2857	2.66681	7.112
Posttest control	70.83	81.67	2647.48	75.6423	2.55713	6.539

Based on Table 3, it is known that at the time of the pretest, the lowest score of scientific attitude in the experimental class and the control class was the same, namely 69.17, and the highest score of scientific attitude in the experimental class was 80.83 while in the control class it was 80. At the post-test, the lowest score of science process skills in the experimental class was 75 while in the control class was 70.83, and the highest score for science process skills was 82.50 while in the control class 81.67.

Table 4. Average value of scientific attitudes in each dimension

No.	The dimension of Scientific Attitudes	Virtual Laboratory Media		Conventional	
		Pretest	Posttest	Pretest	Posttest
1	Attitude of curiosity	76.55	78.81	74.40	79.28
2	Responsibility	75.00	78.69	75.71	72.74
3	Discipline attitude	75.48	78.93	71.78	71.07
4	Honest attitude	80.36	81.67	74.28	80.36
5	Careful attitude	72.26	75.71	75.24	74.76
	Average	75.93	78.76	74.28	75.64

Based on the calculation of the pretest and posttest scores of scientific attitudes in the experimental class shows that there is an increase in the value by a difference was 2.83. The pretest score had an average was 75.93, and the post-test score had an average was 78.76 and the increase occurred on all dimensions of scientific attitudes in the experimental class (Table 4).

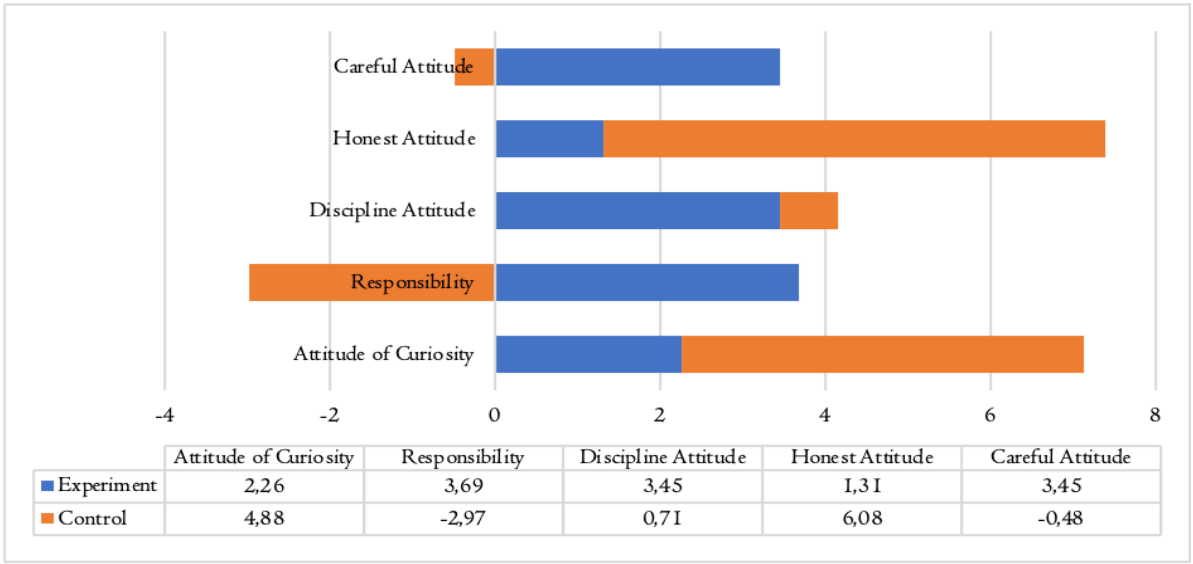

Figure 2. The result of increase in average score in each dimension of scientific attitude

Figure 2 shows the increase in the average value of each dimension of scientific attitudes in the experimental class and the control. The study's findings indicate that the average scores of

responsibility attitudes, disciplinary attitudes, and conscientiousness in the experimental class experienced a higher increase than the control class. However, for curiosity and honesty, the mean score increase in the experimental class was not much higher than that in the control class. Besides, it is also known that the value of responsibility attitude is the highest increase in scientific attitude and honest attitude is the lowest increase after using virtual laboratory media.

The mean value of students's pretest and posttest that has been obtained from the scientific attitude instrument has calculated the normalized gain value (%) on each dimension of scientific attitudes. The results of the normalized gain score calculation can be seen in Table 5.

Table 5. Normalized gain score (%) scientific attitude

No.	The dimension of Scientific Attitudes	N Gain Score (%) ± SD	
		Experiment	Control
1	Attitude of curiosity	9.64 ± 3.35	19.06 ± 15.38
2	Responsibility	14.76 ± 3.35	-12.23 ± 15.38
3	Discipline cttitude	14.07 ± 3.35	-2.52 ± 15.38
4	Honest cttitude	6.67 ± 3.35	23.64 ± 15.38
5	Careful cttitude	12.44 ± 3.35	-1.94 ± 15.38
	Mean	11.51	5.20
	Min	6.67	-12.23
	Max	14.76	23.64

Based on the results of the calculation of the N gain score in Table 5, it is known that the increase in the average value in the experimental class is greater than the control class and has an increase in the difference of 6.31%.

Table 6. ANCOVA test results of the scientific attitudes score on students

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected	339.817	2	169.909	49.255	.000
Model	110.037	1	110.037	31.899	.000
Intercept	169.496	1	169.496	49.135	.000
Pretest	76.634	1	76.634	22.215	.000
Class	231.123	67	3.450		
Error	417782.900	70			
Corrected Total	570.940	69			

In the ANCOVA test, which was carried out on the post-test and pretest data on scientific attitudes, the results were shown in Table 6. Hypothesis testing using ANCOVA with $\alpha = 0.05$. Based on Table 4, it is known that the significance value is 0.000 <0.05, so that H0 is rejected. So it can be concluded that without a pretest, at the 95% confidence level, there is an effect of the use of virtual laboratory media on the posttest scores of students's scientific attitudes.

DISCUSSION

Based on ANCOVA test results on students's scientific attitudes, it was obtained that a significance value was 0.000 <0.05 (Table 6). It was concluded that the use of virtual laboratory media affected the increase in students's scientific attitudes, but the pretest did not influence the increase. According to the calculation results, it is known that the average value in all dimensions of scientific attitudes has increased after using virtual laboratory media. The average increase in value was 2.83 (Table 4). This shows that the use of virtual laboratory media has a positive effect on students's scientific attitudes. This is in line with previous research, which shows that the scientific

attitude of the group that using virtual laboratory media is higher than the group that using conventional media (Al-Balushi, 2009; Hayat, Anggraeni, & Redjeki 2011; Shah & Khan 2015; Gaffar, 2016; Hizbi, 2019; Ekaputra, 2020). Changes in scientific attitudes prove that a person's attitude is not innate but can change or be dynamic due to the influence given, such as the learning process (Dayakisni & Hudaniah, 2006). However, the low increase in scientific attitudes is suspected because the time needed to develop students's scientific attitudes is less than optimal. Time limitations will affect the effectiveness of efforts to increase scientific attitudes because scientific attitudes are a combination of several mental habits, or the tendency to react consistently to an object; it requires a long and consistent period in developing a scientific attitude in a person (Galaud & Hukins, 2002).

The first dimension of the scientific attitude is curiosity. An attitude of curiosity is an act that always seeks to find out more deeply and extensively by investigating something that is learned, seen, and heard. (Samani & Hariyanto, 2012; Daryanto & Darmiatun, 2013). Based on the study results, the attitude of curiosity had an increase in the average value was 2.26 (Table 4). Increased curiosity in students is likely due to virtual laboratories, including learning media that are new to them; therefore, it contributes to the curiosity or curiosity of students indirectly to carry out practicum and obtain information (Krech & Ballanchey, 1962; Supriyadi & Yunia, 2017). Curiosity in students is also encouraged through the questions given (Harrison, 2014). In virtual laboratory media, some questions and orders may participate in influencing the increase in curiosity of students.

However, based on the calculation results, the results show that the increase in the average value of curiosity in the experimental class is no better than the average value of curiosity in the control class. The possibility of this is because students are much more enthusiastic when they see new objects directly. In principle, to help build curiosity in students in learning science through direct experience (Mustari, 2011).

The second dimension of scientific attitude is the attitude of responsibility. Responsibility is a person's behavior to fulfill obligations and tasks that must be carried out (Mustari, 2011; Daryanto & Darmiatun, 2013). Observation activities, analyzing observational data, and reporting observation's results can foster an attitude of responsibility very well in students (Bilgin, 2009; Bayram & Comek, 2009). Therefore, the attitude of responsibility to students can be increased with virtual laboratory media. In virtual laboratory media, students's responsibility attitudes are trained with media independently, which means students must operate, answer questions on the quiz content, make observations on practicum content, and report individual observations.

The third dimension of scientific attitude is discipline. Discipline is individual behavior formed from a series of activities that require a sense of obedience, awareness, order, and a feeling of pleasure in carrying out all applicable regulations (Hadianti, 2008; Ardiansyah & Prasetyo, 2013; Suradi, 2017). So it can be concluded that a disciplined attitude can be formed with a series of activities in which it requires obedience, awareness, order, and pleasure feelings. Based on the study results, there was an increase in the average value of discipline through the use of virtual laboratory media (Table 4). This is probably due to practicum content on virtual laboratory media that displays research activities sequentially with an attractive and fun appearance (Suryanda, Rusdi, & Kusumawati, 2017). It is hoped that it can make students accustomed to discipline in doing practicum. Also, it is known that media that displays audio can improve students's attitudes towards discipline (Purnama, 2015). Virtual laboratory media is a media that has audio facilities; therefore, it is possible that this also encourages an increase in disciplinary attitudes in students who use virtual laboratory media.

The average value of disciplinary attitudes is better in the experimental class compared to the control class, because in the experimental class, students can complete observations on time and are

not preoccupied with preparing tools and materials if some tools or materials have been forgotten to bring (Yanti, Masril, Hidayati, & Darvina, 2019). The fourth dimension of scientific attitude is conscientiousness. A conscientious attitude is careful, unhurried, and thorough behavior in carrying out an activity in order to avoid mistakes and get good results (Ashari, 2015). Increasing conscientious attitudes can be done by conducting observational activities, analyzing data from observations, and reporting observations (Bilgin, 2009; Bayram & Comek, 2009).

In the virtual laboratory media, there is practicum content that contains virtual observation activities, and students are required to report the results of their observations. Based on the results of the study, it is known that the conscientious attitude of students who use virtual laboratory media has increased (Table 4). However, the average value increase is not significant; this is likely because students do not have a sense of wrongdoing when doing scientific work. After all, with virtual laboratory media, students can easily carry out practicum activities without worrying about making mistakes, not to practice accuracy (Handayani, Tapilouw, Wulan, 2018; McMaster, 2011). Also, in the Virtual Laboratory media, students only make observations in a simple form (such as only observing the shape of a moving device), so students are still not used to making detailed observations of an object or phenomenon. Students's low attitudes of accuracy are caused by students being unaccustomed to making detailed observations of an object or phenomenon and repeating the time of measuring and recording research data (Ulva, Ibrohim, & Sutopo, 2017).

The fifth dimension of scientific attitude is honesty. Honest attitude is the act of someone who is accustomed to objectively assessing an object (Purnama, 2015). Based on the research results, it turns out that the increase in honesty in the experimental class is lower than the control class (Figure 2). Even though it should be with virtual laboratory media, students are better trained to do it independently and not collaborate with other friends. This is not in line with research conducted by Sari (2013), which explains that virtual laboratory media can train honest attitudes to students, especially during practicum. The attitude of honesty among students may be influenced by other factors such as desire, group affiliation, and personality (Krech & Ballanchey, 1962).

CONCLUSION

Based on the research results, it is known that it is true that virtual laboratory media can improve scientific attitudes in students. This is known based on the increase in students's average value of scientific attitudes after using virtual laboratory media and the ANCOVA test results, which state that the significance value is 0.000 <0.05. Then, the results of this study can be used as a reference in determining learning media of Protists especially for senior high school students of class X MIA and also it can be used as an information or a reference about the problems of scientific attitudes in students.

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