Effects of use 3D visualization virtual reality to increase scientific attitudes and cognitive learning achievement

To cite this article: Ika Setiawati A Bakar et al 2019 J. Phys.: Conf. Ser. 1397 012040

View the article online for updates and enhancements.
Effects of use 3D visualization virtual reality to increase scientific attitudes and cognitive learning achievement

Ika Setiawati A Bakar¹, K H Sugiyarto² and J Ikhsan²

¹Chemistry Education Program, Graduate School of Yogyakarta State University, Indonesia
²Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Indonesia

*Corresponding author e-mail: setiawatyika68@gmail.com

Abstract. This study was conducted to analyze the effect of the use of 3D visualization media with virtual reality on the achievement of cognitive learning and scientific attitudes of students on chemical equilibrium topic. This study was a quasi-experimental with only posttest design with the subject of research in class XI of State High School of Ternate consisting of 31 students for the experimental class and 27 students for the control class. Collecting cognitive learning achievement data with test and scientific attitudes using questionnaires. The statistical analysis used was MANOVA to measure differences in cognitive learning achievement and scientific attitudes of experimental and control class students. The results showed a significant difference in cognitive learning achievement and scientific attitudes between classes using virtual 3D visualization media and discovery learning models with classes that only use discovery learning models. The implementation of practicum using 3D visualization media with virtual reality can provide opportunities to students to learn about the implementation of the practicum that they design by themselves.

1. Introduction

Growing information technology presents numerous innovations in various fields. Likewise in the education system that gets the impact of the development of information technology. In the world of education, forms of learning activities using information technology are arranged to assist in constructing concepts in learning. The education also began to prepare the delivery of material to students by using information technology capabilities, with the hope that the material delivered is capable to be easily understood by students and also can advance the quality of education especially in the learning of chemistry.

Chemistry topics that requires expertise in calculating, memorizing, and conducting experiment, are often difficult for students to learn [1]. Chemistry knowledge also has levels, namely submicroscopic, microscopic, and symbolic. These three levels are very important in the chemistry learning. The learning process chemistry is not confined to theories or concepts, but also supported by laboratory experiments to prove and develop the theory learned. The function of the laboratory is to provide completeness for accepted theoretical lessons, provide and foster the courage to seek the nature of scientific truths from an object in the natural and social environment, adding skills in using
tools [2]. Laboratories are very important to make abstract chemistry concepts become concrete and make chemical material easier for students to understand [3].

One of the most efficient ways of learning chemistry is through laboratories [4]. The practicum can also provide better results for increasing the understanding of students in the practiced material. In addition to improvement in learning achievement, practicum can also improve the scientific attitude of students. However, learning at school still does not utilize the laboratory due to a lack of tools and materials in the laboratory. Chemicals also require large costs and some trials are at risk for safety.

In general it can be said that the implementation of activities in the laboratory is very important in chemistry learning, but for some reasons this activity cannot be carried out properly. So, we need an alternative laboratory or media that can assist learners in doing practical work they need. One way to help students is through learning media. Media that can be used are embodied learning media technology with three-dimensional (3D). 3D visualization technology was introduced using virtual reality (VR) which is used for chemistry learning.

The VR concept refers to the system of principles, methods, and techniques used to design and create software products to use by several multimedia computer system with particular device system [5]. Virtual laboratory brings advantages that practitioners can conduct dangerous experiment without endangering themselves or others, the simulation is affordable, and after the virtual laboratory is developed, and the practitioners are able to conduct the experiment without great expense [6]. The purpose of this study was to determine the differences between the scientific attitudes of high school students and cognitive learning achievement in the use of three-dimensional visualization media with virtual reality.

2. Methods

This study uses a quasi-experimental method with a posttest only control group design. The sample in this study using two classes of experimental classes and control classes. The experimental class uses discovery learning models with 3D visualization media using virtual reality and control classes using discovery learning models. The trial design can be seen in Table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Group</th>
<th>Method</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experimental</td>
<td>Y1</td>
<td>X1,X2</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>Y2</td>
<td>X1,X2</td>
</tr>
</tbody>
</table>

Note:
Y1: students use 3D visualization media with virtual reality with discovery learning models;
Y2: students using discovery learning models;
X1: scientific attitude questionnaire;
X2: test cognitive learning achievement.

In this study using, a sample of 58 consisting of two classes, the experimental class with 31 students and the control class with a total of 27 students taken from one school in Ternate. The sample used is random sampling technique. The experimental class was treated with the implementation of 3D visualization media with virtual reality with discovery learning while for the control class using discovery learning.

2.1 Instruments

The instrument used in this study is a question of cognitive learning achievement test consisting of 10 essay questions and scientific attitude questionnaire. The question of cognitive learning achievement test before use is done by expert validation and empirical validation. Empirical validation is done by testing the test of learning achievement questions for high school students. Analysis of the results of
empirical validation using the QUEST program to find out the number of fit questions that meet the requirements is used based on the difference in power and level of difficulty of the questions.

2.2 Data Analysis
Differences scientific attitude and cognitive learning achievement were statistically analyzed using Multivariate Analysis of Variance (MANOVA) using SPSS 21. Analysis Manova has carried out in this study via procedures.

- a. Interval data and ratio
- b. Independent variable consists of two or more categories
- c. The observation is independent
- d. The number of samples must be adequate
- e. There is no univariate or multivariate outliers
- f. There is multivariate normality
  - The normality test is used to find out whether the data is normally distribution or not. Data normality test used in the study was based on ratio of the cost of a Mahalanobis distance and the chi square value using SPSS software. Data can be said to be normally distributed if the significance is greater than 0.05 or p-value > 0.05 at a significance level of 5%
- g. There is a linear relationship between each pair of dependent variables and each independent variable
- h. It has covariant metric homogeneity
  - Homogeneity tests were conducted to determine whether the sample came from a homogeneous population or not. The homogeneity test of the covariance matrix in this study uses the Box’s M. test. The covariant variance matrix is said to be homogeneous if the value of sig. > α (0.05).
- i. There is no multicollinearity.
- j. Correlation Test
  - Correlation test is useful for knowing the relationship between one variable and another. This study uses Pearson test with the help of SPSS software. The data has correlation if the significance value was less than 0.05 or p < 0.05 at a significance level of 5%. If the hypothesis prerequisite test is fulfilled then MANOVA analysis is performed using SPSS to determine the difference between the experimental group and the control group.

3. Results and Discussion
In this study, the learning achievement data in the form of posttest results are given to the students after receiving treatment with media using virtual reality 3D visualization. The results showed that the use of virtual reality 3D visualization media with discovery learning learning model produces a difference of learning achievement and scientific attitude with class without the use of media. Virtual chemistry laboratory has a positive effect on achievement and scientific attitude of learners [7].

Prerequisite analysis carried out is the normality test and homogeneity test. The results of the normality test can be seen in Table 2.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Class</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific Attitude</td>
<td>Experiment</td>
<td>0.858</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>0.744</td>
</tr>
<tr>
<td>Cognitive Achievement</td>
<td>Experiment</td>
<td>0.193</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>0.152</td>
</tr>
</tbody>
</table>

Based on Table 2, it can be seen that the significance value of scientific attitudes and cognitive learning achievement of students from the experimental class and control class is greater than 0.05 so
that it can be concluded that the data is normally distributed. The homogeneity of the variance-
covariance matrix test was performed using the Box’s-M Test. The results of the homogeneity test
obtained Box’s M value of 0.230 with an F value of 0.074 and a significance value of 0.974. The
significance value obtained is greater than 0.05 so that the covariance matrix is homogeneous.

After the prerequisite test of normality and homogeneity done, proceed to test the hypothesis,
MANOVA test was used to test whether there are differences in the scientific attitude and cognitive
learning achievement of learners using instructional media 3D virtual reality visualization and learners
who do not use the media. A summary of the results of the manova test can be seen in Table 3.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pillai’s Trace</td>
<td>0.116</td>
<td>3.619</td>
<td>2,000</td>
<td>0.033</td>
</tr>
<tr>
<td>Wilks’ Lamda</td>
<td>0.884</td>
<td>3.619</td>
<td>2,000</td>
<td>0.033</td>
</tr>
<tr>
<td>Hotelling’s Trace</td>
<td>0.132</td>
<td>3.619</td>
<td>2,000</td>
<td>0.033</td>
</tr>
<tr>
<td>Roy’s Largest Root</td>
<td>0.132</td>
<td>3.619</td>
<td>2,000</td>
<td>0.033</td>
</tr>
</tbody>
</table>

Based on the manova test, the significance value of 0.03 is smaller than 0.05, indicating that there
are differences in scientific attitudes and cognitive learning achievements of students who use 3D
visualization media with virtual reality and those who do not use the media. There are several factors
that cause the learning in the experimental class higher than in the control class, namely the learning
using 3D visualization media with virtual reality that makes the students be more interested in
learning. The learning process with virtual laboratory can also be carried out independently by the
students so that they become more focused on conducting a practicum. Virtual media let students to
conduct the experiment easily and to help students understand the concept. The use of 3D visualization
media with virtual reality can help students understand the practicum results because the students can
repeat the practicum that has been done in the learning so that it can deepen their experience and
material that has been learned [8].

In the experimental class, aspect of curiosity has the highest score because of the learning media
use. The existence of virtual laboratory is a new thing for students, so that it creates their curiosity to
ask and investigate the things that the students do not know yet and to attract the students to learn. The
advantages in general are that the learning process becomes more interesting, interactive and
appropriate to stimulate students’ curiosity. Implementation of media is able to increase students’
science attitude. Demonstrated that the use of virtual laboratory can give an experience and improve
students’ learning motivation [4]. The dominant science attitude in the control class are open
mindedness and cooperation, namely the indicator on showing respect for other opinions and findings.
In the control class, the students are accustomed to work in groups so that they more appreciate the
other students’ opinions and findings. Students’ good attitudes and interests on the use of virtual media
will have a direct effect on the improvement of their learning outcomes [9].

This study does not claim that laboratories with virtual reality are more effective than real
laboratories, but laboratories with virtual reality can be an alternative for reasons such as the dangers
of chemical reactions, time problems, lack of tools and materials in real laboratories. The use of
laboratory media has become an increasing issue [10]. Learning using a virtual laboratory is a
simulation, whereas, a real laboratory is a conventional practicum learning in the real situation. In this
study, the laboratory using virtual reality can also be utilized as an alternative for the lack of practical
equipment and learning media that support students to better understand the concept of chemical
equilibrium. Media in the virtual laboratory is a medium used to help students understand a subject
and can provide a solution to the lack and absence of laboratory tools [11].

Learning with 3D visualization media with virtual reality can be used for self-directed learning if
the students want to repeat the practice. Learning with virtual laboratory can provide flexibility in time
and place and can overcome other obstacles in the school’s laboratory [12]. The use of instructional media technology 3D visualizations using virtual reality to make the participants more interested in learning. Moreover, it can improve learning and make learning more effective, adding to the experience of learners and also provides practical needs of learners. 3D Visualization using virtual reality make learners feel as though I was in a real laboratory. Learners are more motivated in learning using a virtual 3D environment. The use of information, communication and technology can be a good opportunity to create chemical learning programs with effective tools to develop new methods and techniques in educational programs [13].

4. Conclusion
The conclusion of this study is that there are significant differences in cognitive learning achievement and scientific attitudes between classes using virtual 3D visualization media and discovery learning models with classes that only use discovery learning models for chemical equilibrium subjects. The implementation of practicum using 3D visualization media with virtual reality can provide opportunities to students to learn about the implementation of the practicum that they design by themselves. As a result, the students become active and creative in learning chemistry and the use of technology-based media is able to make the learning process interesting for students.

5. References