European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.2958411 Volume 6 | Issue 2 | 2019

USING VIRTUAL REALITY TOWARDS STUDENTS' SCIENTIFIC ATTITUDE IN CHEMICAL BONDING

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Abstract:
This study is aimed at determining the effectiveness of using virtual reality (VR) toward students' scientific attitude in chemical bonding. The data was collected through questionnaire consisting of 14 items. A quasi-experiment with a post-test design was employed in this study. The population was the students of 10th public senior high school in Gunungkidul Regency. A total of 96 grade 10th students were cluster randomly selected from a public senior high school. The samples were set into three different classes, namely control group (CG) using a real laboratory, experiment group-1 (EG-1) using a virtual reality integrated hybrid learning, and experiment group-2 (EG-2) using both of them. The data related to students' scientific attitude were analyzed using ANOVA. Scientific attitude scores were significantly different between the class using a real laboratory, the class that was using virtual reality, and the class that using both of them. This study implies that VR can be used to improve students' scientific attitude.

Keywords: scientific attitude, virtual reality, hybrid learning, chemical bonding

1. Introduction

The progress of science and technology is growing so rapidly in the current era of globalization, especially in education. This requires the teacher to be more innovative and creative in carrying out learning activities in the classroom so that students are expected to be more active and easier to understand the subject matter. The use of

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learning media is one of the benefits of the progress of science and technology that can be used to make learning more interesting. Unfortunately, currently information and communication technology (ICT) has not been used optimally as a media in the science learning process (Sumintono et al, 2012).

Chemistry is one of the lessons with abstract material. Most students regard chemistry as a difficult subject because it contains abstract concepts that require imagination to understand the concept (Woldeamanuel et al, 2014). Chemistry as part of science is very closely related to practicum. Practicum helps students to find scientific concepts, increase interest, motivation, practical skills, and problem solving abilities of students (Högström et al, 2010). However, nowadays many schools do not take advantage of laboratory facilities and even if they exist, practicum is carried out separately with theoretical learning in the classroom.

Learning by utilizing ICT can make students become more active, independent, competitive, and have global insight, one of which is virtual learning. Virtual learning is a new generation of types of learning using computers (Bakar et al, 2013). Chemical practicum can be carried out by utilizing ICT using a virtual laboratory. The use of virtual laboratories has increased with the high cost of traditional laboratories and the development of distance learning. Several studies on virtual laboratories have been developed and implemented in the learning process. Virtual laboratories are efficiently implemented in learning and can help develop students' experimental abilities (Elsunni & Abdelwahed, 2014). Virtual chemistry laboratories can create a collaborative learning environment so students are more active in learning in the classroom (Tsovaltzi et al, 2010). Therefore, it is necessary to develop virtual laboratories as learning media in order to optimally utilize ICT.

The development of virtual reality is very promising for future technology that can be developed as a medium for virtual experiments. The use of instructional media can make learning more interesting and motivating, more interactive, subject matter easier to understand, learning methods become more varied, learners become more active, and learning processes can take place anytime and anywhere (Anwariningsih & Ernawati, 2013). Virtual reality can make interface to e-learning applications and possible to get a sense of a 3D environment with 3D visualization (Kader, 2011).

Virtual reality applies hybrid learning, which is learning that combines face to face and online. Hybrid learning can make the learning atmosphere more interesting and interactive. In addition, students can also study online outside of school hours and anywhere. Online learning can improve teaching and learning process because it can be use at anytime and anywhere to anyone (Govindasamy, 2002). The 21st century skills encourage students to develop their participation in learning, encourage communication and cooperation, improve their critical thinking skills, and find a concept through their creativity in order to solve a problem. The role of the teacher in learning is only as a facilitator and guiding students to find concepts. Science learning should foster scientific skills that include process skills, creative thinking skills and critical thinking, and scientific attitudes (Heng et al, 2002).

Scientific attitude is the desire to know and understand, dispel ignorance and backwardness, questioning to statements, search for data and their meaning, search for verification, and consideration of consequences to balanced perspective (Lawson, 1982; Osborne et al, 2003). Scientific attitude components are rationality, unbiased, truthful, open mindedness; possess love for knowledge, curiosity, objectivity, and intellectually honest (Emina, 1986; Jancirani et al, 2012). Overall, the virtual reality on hybrid learning could facilitate students in learning process and provide an alternative to enhance students' scientific attitude. Hence, this article concerned to analyze the differences of using virtual reality in the chemistry learning toward the aspects of students' scientific attitude in chemical bonding lesson.

2. Literature Review

2.1. Virtual Reality

Virtual reality (VR) is a new technology that is innovative and interesting that aims to visualize the real world with the environment through computer programs and involving the five senses. Virtual reality (VR) allows users to enter and experience a digital environment in real-time so that it is as if they are in that environment. Zhi-qiang (2017) states that virtual reality (VR) is also known as immersive visualization which is a 3D interpretation environment, an artificial virtual environment produced by computers, the result of 3D space construction with computer graphics to get users into the 3D virtual world.

Virtual laboratories are virtual reality environments that simulate the real world for learning purposes on discovery learning (Muhamad et al., 2010). Elsunni & Abdelwahed (2014) explained that to improve students' research skills, virtual laboratories are very useful in helping students understand how to design research experiments because using a computer system can provide a good simulation of what should happen in the real world, and can help them to collect data, analyze, and train students to understand how a scientist can explain what they are researching.

2.2. Hybrid Learning

Hybrid learning is a learning that combines face-to-face learning between students and teachers with ICT-based online learning. Digital literacy is the ability to use ICTs in finding, evaluating, utilising, sharing, and creating information found online of open distance and e-learning (Maphosa & Bhebhe, 2019). According to Klimova & Kacetl (2015), there are three general understandings of hybrid learning, as described below.

a) Integration of traditional learning with a web-based online approach.
b) A combination of media and tools (such as textbooks) are used in e-learning environments
c) The combination of a number of teaching and learning approaches regardless of the technology used.

The stages of hybrid learning include the following (Lalima & Dangwal, 2017)

a) Face to face teaching;

b) Student interaction with learning material;
c) Peer group interaction;
d) Group discussion and exchange of ideas;
e) Access electronic library;
f) Virtual learning;
g) Online assessment;
h) Electronic personal guidance;
i) Accessing and maintaining educational blogs;
j) Webinars (hybrid learning application);
k) Learning by looking at expert lecturers on YouTube;
l) Online learning through videos and audios;
m) Virtual laboratories.

Based on this explanation, hybrid learning is a learning system that combines face-to-face learning and online through the internet at the same time or at different times so that students are more flexible in understanding about learning material.

2.3. Scientific Attitude

Scientific attitude is an activity where students carry out scientific research to hone their scientific knowledge and skills. According to Olasehinde & Olatoye (2014), scientific attitudes are the ability to react consistently, rationally, and objectively in certain ways to problematic situations. Jancirani et al. (2012) states that scientific attitudes are a combination of qualities and virtues reflected through one's behavior. The role of the teacher in the teaching and learning process also influences the motivation to be scientific in students (Senler, 2016). When the teacher gives examples of scientific attitudes in learning activities, it will lead to a desire in students to participate in doing scientific attitudes in their daily lives. Someone who has an attitude of curiosity, attitude of discovery, critical thinking, and firm stance is someone who has a scientific attitude (Gegga, 1977).

Some characteristics of the scientific attitude according to Antonoglou et al. (2011), are open thinking, curiosity, fact-based assessment, ready to test and verify conclusions, ready to reconsider their decisions, free from pressure and false beliefs, honest in recording, and collecting and reporting data. Pitafi & Farooq (2012) classify scientific attitudes in the form of curiosity, rationality, open-mindedness, critical thinking, objectivity, honesty, responsibility, and humility.

3. Material and Methods

A quasi-experimental method with a post-test only design was set in this study. The samples were set into three different classes, namely control group (CG) using a real laboratory, experiment group-1 (EG-1) using a virtual reality integrated hybrid learning, and experiment group-2 (EG-2) using both of them. The research design can be seen in Table 1.

Table 1: Research Design

Classes	Treatment	Post-test
Control Group (CG)	X1	P1
Experiment Group-1 (EG-1)	X2	P1
Experiment Group-2 (EG-2)	X3	P1

Note: X1 = chemical bonding teaching learning with real laboratory, X2 = chemical bonding hybrid learning mediated by virtual reality, X3 = chemical bonding teaching learning with real laboratory and hybrid learning mediated by virtual reality P1 = scientific attitude questionnaire

The participants in this study came from senior high school in Gunungkidul Regency with cluster random sampling technique. A total of 96 grade 10th students participate in this study. The samples classified into three different classes which were a CG of 32 students, EG-1 of 32 students and EG-2 of 32 students. The research design in this study can be seen in Table 2.

Table 2: Research Setting

Hybrid learning phase	Class		
	CG	EG-1	EG-2
1st and 2nd meeting			
Face to face	Discussion, question and answer, presentation, individual task, feedback	Discussion, question and answer, presentation	Discussion, question and answer, presentation
Online	-	Individual task, feedback	Individual task, feedback
3rd meeting			
Face to face	Practicum in real laboratory, discussion, presentation, question and answer	Discussion, question and answer	Practicum in real laboratory, discussion, question and answer
Online	-	Practicum with virtual reality, task, feedback	Practicum with virtual reality, task, feedback
4th meeting			
Face to face	Discussion, question and answer, presentation, exercise, feedback	Discussion, question and answer, presentation	Discussion, question and answer, presentation
Online	-	Exercise, feedback	Exercise, feedback

The variable measured in this study was the student's scientific attitude with a questionnaire consisting of 14 items using 4 scales. This questionnaire was synthesized from several books and journal articles on scientific attitude including objectivity, curiosity, cooperation, and open-mindedness. The questionnaire was validated with content and empirical validation. The content validation of scientific attitude questionnaire conducted by asking the judgments from lecturer cover the aspect of material, construct, and language. While the empirical validation was tested against 275 students. The data of empirical validation was analyzed with the Cronbach's Alpha value found to be 0.84. An observation sheet was used to determine the activities of students' scientific attitude during the teaching-learning process to support the data which obtained from the questionnaire. Analysis of Variance (ANOVA) technique and qualitative descriptive used to analyze students' scientific attitude.

4. Results and Discussion

Virtual reality can be operated using an Android equipped with 3D glasses and a controller. Implementation of virtual reality laboratory was conducted in 4 meetings. The display of virtual reality laboratory can be seen in Figure 1 and Figure 2, while the learning process with VR can be seen in Figures 3.

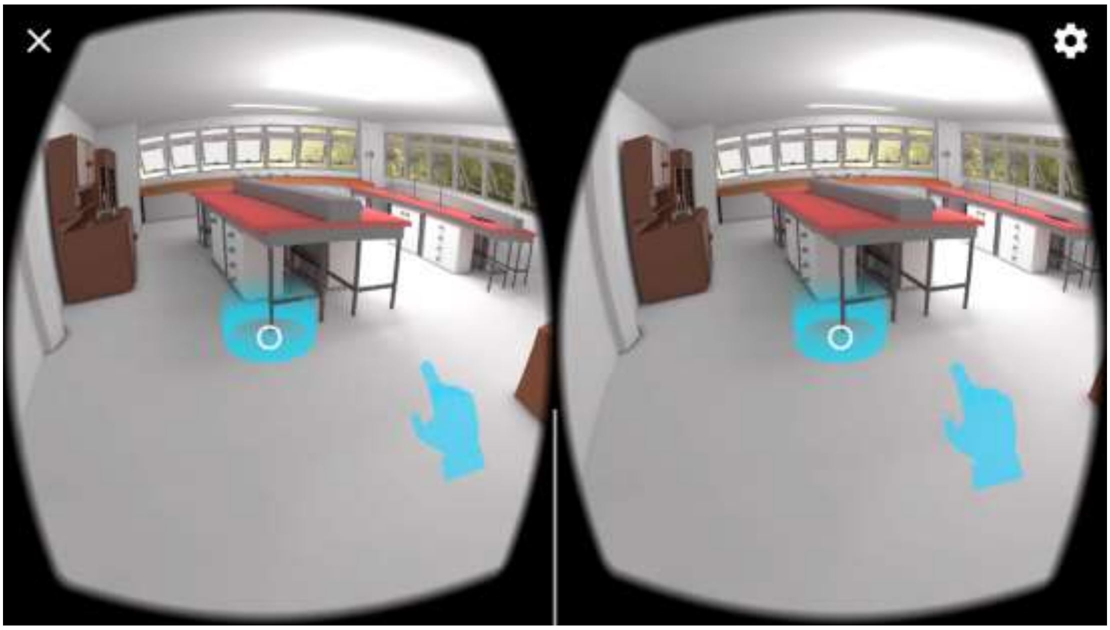

Figure 1: Virtual reality laboratory

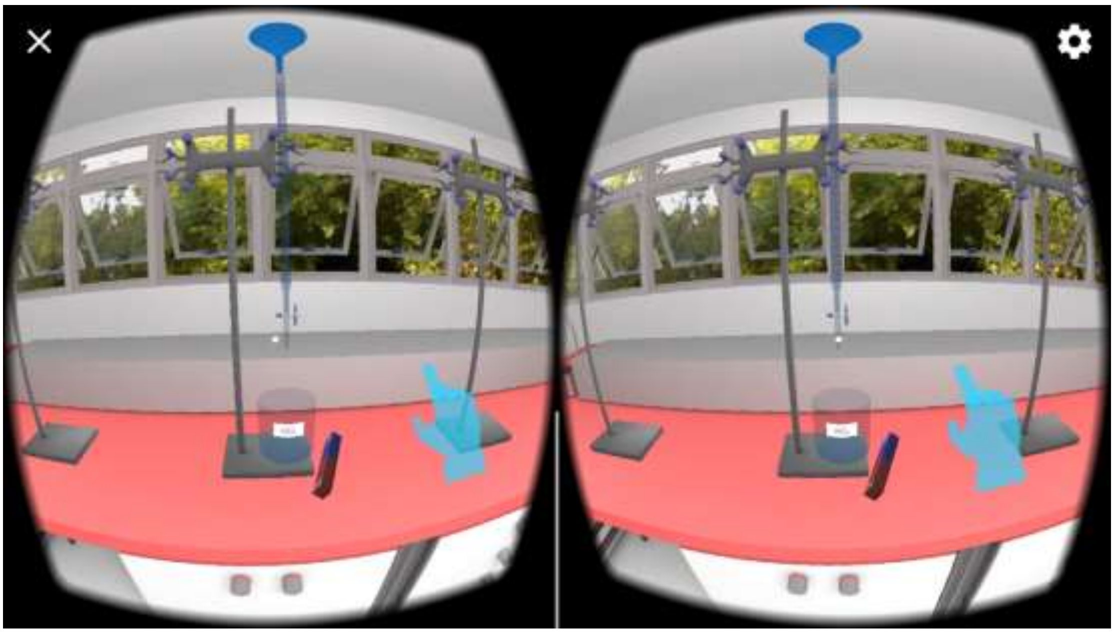

Figure 2: Practicum in virtual reality

Figure 3: Learning process with VR in class

Virtual reality helps students to improve their imagination by developing a student's capacity follow near invisible cues and enhance scientific attitude. VR was effective tool to foster the skills and undergraduate students' understanding of concepts.

After implementation of VR in the learning process, then we did a posttest to measure students' scientific attitude. It was done by giving questionnaires to students. The average score of students' scientific attitude between three classes can be seen in Figure 4.

Figure 4: The average score of students' scientific attitude

Figure 4 showed that the average score of students' scientific attitude for class CG was 39.88, class EG-1 was 46.01, and class CG-2 was 47.57. The average score of three classes were different, class CG-2 had highest score among them. Before ANOVA analysis, normality and homogeneity tests were carried out to find out whether the data came from a normal and homogeneous population. The normality using Kolmogorov-Smirnov test and homogeneity using Levene tests can be seen in Table 3 and Table 4.

Table 3: Result of Normality Test

Class	Sig. Value	Conclusion
CG	0.069	Normal distribution
EG-1	0.063	Normal distribution
EG-2	0.200	Normal distribution

Table 4: Result of Homogeneity Test

Levene Statistic	Sig. Value	Conclusion
1.625	0.202	Homogeny

Based on the result test, it can be conclude that data came from a normal and homogeneous population, so the test continued. Meanwhile, the summary of ANOVA test can be seen in Table 5.

Table 5: Result of ANOVA Test

F Value	Sig. Value	Conclusion
16.245	0.000	Significantly different

Based on Table 5, it shows that there was significant influence of virtual reality towards student's scientific attitude. According to Post Hoc test, the significant difference of student's scientific attitude was found between class EG-2 with the other classes (CG and EG-1), but class EG-1 had a higher average score than class CG.

This study was conducted to examine the effectiveness of a virtual reality (VR) toward students' scientific attitude in senior high school. The virtual reality used in learning help students to experiment according to the aims. The VR is equipped with oculus and controller to facilitate the operation of the media. It was implemented in the learning process and during the lesson observations were made. After that, students were given a questionnaire to see how far their scientific attitude. Before the data was analyzed, the score of students' scientific attitude converted into interval data scale.

The use of virtual reality integrated hybrid learning gives a positive effect toward student's scientific attitude on chemical bonding lesson. The significant differences of ANOVA analysis on student's scientific attitude were caused by the different media employed in teaching-learning. In class EG-1 was employed virtual reality integrated hybrid learning and class EG-2 was employed real laboratory with virtual reality integrated hybrid learning. Meanwhile, in the class CG was employed real laboratory. Class CG with real laboratory practicum takes more time than a virtual reality. Virtual reality make learning atmosphere more interactive, students more active, and develop their experimental abilities. Learning with virtual programs can enhance students' understanding (Çelik et al, 2014) and virtual laboratories enable students to develop their ideas and identify problems (Shyr, 2010).

The virtual reality enrich the knowledge and interest of the students. In class EG-1 and EG-2 which used virtual reality makes students more motivated to learn chemical bonding learning. Virtual laboratories are very useful in helping students understand how to design research experiments and improve students' research skills because using a computer system can provide a good simulation of what should happen in the real world, and can help them to collect data, analyze, and train students to understand how a scientist can explain what they are researching (Elsunni & Abdelwahed, 2014).

Hybrid learning divide into two phases: online phase using virtual reality and face to face phase which is similar to learning in the classroom. The online phase of hybrid learning in this study could facilitate students to learn with flexible way because it can used anywhere and anytime. Online phase in hybrid learning consist synchronous virtual collaboration, asynchronous virtual collaboration, and asynchronous self-paced. Synchronous virtual collaboration involves interaction between teachers and students delivered at the same time during working hours (Er et al, 2009). For example utilizing Instant Messaging (IM) or chat. Asynchronous virtual collaboration involves interaction between teachers and students delivered at different times, for example online discussion boards or discussion forums and emails (Diaz & Entonado, 2009). Asynchronous self-paced is a model of independent learning in different times where students can learn the material provided by the teacher in the form of modules, teaching materials, working on assignments and training online (Rhode, 2009).

Virtual reality integrated hybrid learning will make students have a high curiosity, open attitude with fellow friends, objectivity in conducting experiments, and increasing collaboration between individuals in groups. When carrying out a virtual practicum during the learning process, students' scientific attitudes can be observed carefully so that they will be accustomed to behaving scientifically in their actions. Scientific attitude give an effect of success in the classroom. Students who have high scientific attitude will achieve satisfactory learning outcomes and always take full responsibility for doing all the things necessary for effective learning. The use of technology opens the opportunities for students to takes responsibility for their learning and makes students more active in learning (Stanojević et al, 2018). e in educational programs will make students get more benefits in the long term (Pekdag, 2010). Teachers who integrate ICT into learning process will attract students' attention and help teachers to deliver the concepts of subject matter (Cereci, 2018; Ifthinan, 2019).

Students in class CG gain skills of using chemical tools in laboratory. Students in class EG-1 whose practicum using virtual reality can repeat the practice anywhere. Meanwhile, students in class EG-2 get 2 different laboratories: real laboratory and virtual reality. Students get hands-on experience in the laboratory at school and can practice virtually out of school. This class (EG-2) had more benefits than other classes (CG and EG-1) because they can strongly remembered and understand the principles of the practicum. Educational media can influence the students' attitude, providing a positive learning experience, and positively influencing the learning outcomes (Jabbour, 2014). As well as the results of observations that have been made, class EG-2 have a more prominent scientific attitude compared to other classes. Class EG-2 have a higher curiosity during learning and practicum, always asking questions when question and answer and being active in discussions and presentations. This is because they are very enthusiastic when they want to do lab work with virtual reality so that in groups of students work together to complete the practicum and answer the problems during learning. With the data students get when doing practicum in real laboratory, they try to combine practical results with data obtained from virtual reality. Thus, students will get used to having a scientific attitude not only when they are in school but they can also apply scientific attitudes in their daily lives.

A previous study found that the use of 3D virtual reality of plate tectonics had positive change of students' attitude towards science (Kim, 2006). Makarova & Makarova (2018) said that digital educational technologies are the most promising ways to improve the competence-oriented learning process, improve their skills and gain experience. Another study shows that the use of android-based-game and hybrid of the video conference to foster the students' self-regulated learning and impact on students' problem solving skills (Fitriyani et al, 2018; Shalihah et al, *2019*). The innovation of this study was using a virtual reality as supplement rather than as a substitute for real laboratory work. This allows students to repeat the experiment and they can do their own practicum anywhere.

6. Conclusion

Based on the statistical analysis results, it can be concluded that a class using virtual reality integrated hybrid learning with real laboratory (EG-2) is significantly different in scientific attitude from the other class (CG and EG-1). The virtual reality integrated hybrid learning is an interactive media that can be utilized as flexible independent learning sources and make the students gain practical experience and freely to repeat the material of VR anywhere. So, it was effective to improve students' scientific attitude in chemical bonding learning. The results of this study inspire great hope for the future use of virtual reality in another chapter.

Conflict of interests

The authors declare no conflict of interest.

Acknowledgements

Thank you for Kemenristek Dikti (Indonesian Directorate General of Higher Education) for financial supporting of this research through "Tim Pascasarjana" Research Grant 2018.

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