Effectiveness of using virtual chemistry laboratory integrated hybrid learning to students’ learning achievement

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Abstract. This research was conducted to analyze the effect of using virtual chemistry laboratory integrated hybrid learning toward students’ learning achievement on the subject of thermochemistry. Thus, the research was set as a quasi-experiment research using posttest and non-equivalent control group design. By purpossive sampling technique, the samples from 3 classes composed of 1 public senior high school were selected. The classes were divided into experiment class (EG) using both virtual chemistry laboratory integrated hybrid learning and traditional hands-on laboratory, control class 1 (CG-1) using virtual chemistry laboratory integrated hybrid learning only, and control class 2 (CG-2) using traditional hands-on laboratory only. The corresponding data were collected on the basis of a multiple choice test of chemistry learning achievement. The data were then tested by Anova. The results show that there is a significantly different in students’ learning achievement among the three classes EG, CG-1 and CG-2.

1. Introduction
In the era of globalization, the progress of science and technology is growing very rapidly. Delivery of information is quickly needed by all levels of society, including in the world of education. In order to keep up with the development of science and technology, the Government has established policies regarding improving the quality of education in Indonesia, namely by implementing the Curriculum-2013 as a standard for the implementation of national education in Indonesia.

Curriculum-2013 is a scientific approach based curriculum that includes observing, asking questions, gathering information, associating, and communicating for all subjects. The learning process in the Curriculum-2013 is interactive, contextually based, and learner-centered. Learning in the Curriculum-2013 strengthens the learning process and authentic assessment to achieve competencies in attitudes, knowledge, and skills. Authentic assessment includes the readiness of students in following the learning, process, and learning outcomes as a whole [1].

In general, the learning process in senior high school is divided into two, namely the learning process in the classroom and the learning process in the laboratory. In the learning process in the classroom, the teacher places more emphasis on concepts and practice questions so students feel bored. This can be
seen from students who are less enthusiastic and interactive during the learning process so that students are less active and do not use the opportunity when the teacher gives the opportunity to ask questions. In addition, because of the large amount of material that must be learned so that the learning activities in the classroom are not enough. Therefore it’s necessary to have additional learning activities that can be done anywhere and anytime.

Learning process in the laboratory, practical activities haven’t been effective. This can be seen from the inadequate facilities in the laboratory which are the constraints of chemical practicum activities. Limitations of tools and chemicals that are in accordance with the chemical material that will be delivered are obstacles to the smoothness of chemical practicum activities so that students only do practicums without understanding the essential chemical concepts that can be obtained through the practicum.

Students feel that they have the opportunity to be active with other students as a benefit of the online learning environment [2]. The Indonesian Ministry of Education has realized the importance of ICT (Information and Communication Technologies) in learning, as well as implementing learning with multimedia, as in the HYLITE program (Hybrid Learning for Indonesian Elementary School Teachers) organized by the Consortium of 23 PT Indonesia in 2007 - 2010 which was held in ICT-based hybrids.

The implementation of learning using software for practicum remotely in secondary schools is organized and encouraged by the ministry of national education, which can be adapted for chemistry learning in high school with hybrid learning. The rapid development of ICT has introduced an HTML5 program that has not been used optimally as a learning media for Chemistry. Learning achievement scores of students who take hybrid learning are significantly higher than students who follow conventional learning [3].

Hybrid learning is a learning model that integrates innovation and technological progress through online learning systems with the interaction and participation of traditional learning models. Hybrid learning is a pedagogical approach that combines face-to-face instruction with computer-mediated instructions [4] Hybrid learning method is a combination of face-to-face instructional methods and online learning. The advantage of hybrid learning is that learning can be carried out independently by students, learning can be carried out more effectively and efficiently and able to increase accessibility because with the existence of hybrid learning students are easier to access learning materials.

Technology has potential to change the way teachers teach and learners learn. These systems may influence traditional teaching practices, while also introducing a complex layer of management to teaching programs [2]. Learning management systems such as virtual chemistry laboratory integrated hybrid learning at the forefront of recent technological advances in Higher Education.

Interactive learning environment by using animations and simulations for abstract topic, where students become active in their learning, provide opportunities for students to construct and understand difficult concepts more easily. Therefore, use of virtual chemistry laboratory integrated hybrid learning in labs, overcomes some of the problems faced in traditional hands-on laboratory and make positive contributions in reaching the objectives of an educational system. It is not always possible to see the results of students’ studies in a traditional hands-on laboratory, especially in inadequate laboratory conditions. Use of virtual chemistry laboratory integrated hybrid learning can overcome that mistakes occur as a result of such laboratory conditions or misuse of the laboratory.

As part of science, chemistry cannot be separated from the scientific approach and practicum. Therefore it’s necessary to have learning media in the form of interactive media so that students can do practical activities whenever and wherever. Virtual chemistry laboratory integrated hybrid learning is a practical solution to improve students' scientific inquiry in the context of senior high school environments [4]. The virtual chemistry laboratory software is at least as effective as real chemistry
laboratory [5]. Therefore, a support laboratory such as the Virtual Chemistry Laboratory Integrated Hybrid Learning is needed to overcome the realities of real laboratories.

A virtual chemistry laboratory is a simulation that represents real laboratory experiments in as close a form as possible or a computer simulation that allows important functions of laboratory experiments to be carried out on a computer. Chemical learning materials emphasize the provision of direct learning experiences obtained through practicum activities, but there is abstract material. Visualization of subject matter and abstract objects is needed to improve students' understanding of the material. The benefit of having a virtual chemistry laboratory is that students can visualize and interact with the symptoms that will be experienced when conducting experiments in the laboratory.

Virtual experiments can be used to acquaint students with laboratory techniques and procedures prior to their laboratory sessions, so that they can be better prepared to conduct the same or similar experiments in a real-life chemical laboratory. It also allows students to study the items of apparatus, collecting and assembling items of the apparatus, familiarize themselves with laboratory techniques and procedures. It should be emphasized that virtual chemistry experiments are safe even for novices. Students can carry out such experiments that might be dangerous and expensive in a real laboratory [6].

Hybrid learning is a learning model that integrates innovation and technological progress through online learning systems with the interaction and participation of traditional learning models. Hybrid learning methods are a combination of face-to-face instructional methods and online learning. The intellectual ability of students greatly determines the success of students in gaining achievement. To find out whether or not someone is successful in learning, it is necessary to do an evaluation, the goal is to find out the achievements of students after the learning process takes place. Achievement is defined as the results achieved. Learning is closely related to achievement. Learning outcomes are a process of experience categorized into 3 fields, namely cognitive, affective, and psychomotor fields that appear in behavioural change [7]. Achieving learning outcomes that occur within the student is called learning achievement [5].

2. Methods

2.1 Research Design

An experimental research with a quantitative approach was set in this study. The samples in this study were set into three different classes according to the experimental manipulations, namely Class EG using both virtual chemistry laboratory integrated hybrid learning and traditional hands-on laboratory, Class CG-1 using virtual chemistry laboratory integrated hybrid learning only, and Class CG-2 using traditional hands-on laboratory only. The research design can be seen in table 1.

| Class                           | Experimental Manipulations | Posttest |
|--------------------------------|----------------------------|--------|
| Experimental Group (EG)        | X1                         | Y1     |
| Control Group 1 (CG-1)         | X2                         | Y1     |
| Control Group 2 (CG-2)         | X3                         | Y1     |

Note: X1 = thermochemistry teaching learning mediated by virtual chemistry laboratory integrated hybrid learning and traditional hands-on laboratory; X2 = thermochemistry teaching learning mediated by virtual chemistry laboratory integrated hybrid learning; X3
= thermochemistry teaching learning mediated by traditional hands-on laboratory; Y1 = multiple choice of chemistry learning achievement.

2.2 Participants
The participants in this study came from public senior high school in Magelang regency, Central Java, Indonesia. School was chosen because has very good school accreditation and has adequate facilities for implementation of hybrid learning such as the internet network, computer, and smartphone. A total of 143 students with 16 years old average were the participants in this study. By cluster random sampling, those 143 participants then were classified into three different classes which were EG of 33 students, CG-1 of 33 students, and an CG-2 group of 33 students.

2.3 Data Collection
According to the objective of this research, the data that would be implemented were obtained from the multiple choice of chemistry learning achievement. The multiple choice of chemistry learning achievement consisted of 40 points of test. Empirical validity was done by testing the multiple test of chemistry learning achievement against the other students that were not used as the samples of this study. Those students used to test have certain criteria. The criteria in this case include having an average age of 16 years old and have studied thermochemistry subject matter. A total of 263 students were obtained to multiple choice that has been developed. Based on the result of empirical validity analysis there were 40 items of multiple choice does fit with Partial Credit Model (PCM). In addition, the analysis results show an Alpha Cronbach’s reliability estimate of 0.82.

2.4 Data Analysis
Data analysis involved normality and homogeneity test and Anova test. The normality test was used to determine the normal distribution of data, while the homogeneity test was used to know the homogeneity of the population. While Anova was used to know whether there was the significant difference between chemistry learning achievement of students in experimental class and controlled classes.

3. Results and Discussion
The students’ chemistry learning achievement data in this study was obtained from the multiple choice of chemistry learning achievement and measured after the experimental manipulations were performed in each class. Results of this study supported several research results reported in the related literature in which it was claimed that virtual laboratories enriched with simulations has many advantages on increasing students’ chemistry learning achievement. Although the results of this study supported that the use of virtual chemistry laboratory integrated hybrid learning increased students’ chemistry learning achievement levels and made a positive impact on students’ attitudes towards chemistry.

Virtual chemistry laboratories have a positive effect on student achievement and attitudes [9]. We do not claim that virtual chemistry laboratory integrated hybrid learning more effective than the traditional hands-on laboratory activities. Instead, we claim that when we are forced not to perform traditional hands-on laboratory activities, due to reasons such as danger of chemical reactions, time concerns, lack of laboratory or equipment, or insufficient lab conditions which limit us to perform a simple laboratory activity, virtual chemistry laboratory integrated hybrid learning can be an alternative. The use of virtual chemistry laboratory integrated hybrid learning has become an increasing issue regarding science laboratories due to the increasing cost of traditional hands-on laboratories, and the increase in distance education [8].
Therefore, instructional materials are developed by using computers can be a solution for schools which has no science laboratory but has a computer cluster or laboratory. It is obvious that instead of making demonstrative experiment in schools where there is lack of laboratory or equipment or where there are over-crowded classes, virtual chemistry laboratory integrated hybrid learning can be an alternative. Another advantage of using virtual chemistry laboratory integrated hybrid learning is that the cost for preparing a science laboratory which is just used for science lessons is higher than for needed to prepare a computer laboratory which can be used for many different lessons.

However, active will of students to participate learning activities plays an important role to lead the learning being effective. Although a visual instruction developed by computerized technology would make a positive contribution to students’ chemistry learning achievement in most of the scientific topics and concepts, it is also better to kept in mind that using simulations alone does not solve any problem. To gain a better result from the education, simulations must be supported with appropriate instructional methods and software related to the topics and concepts to be taught in the class. Moreover, a detailed lesson plan in which where simulations will be used, when and what students will do, the parameters related to the topics and concepts that students can change in the system must be defined. It is believed that only after these preparations, an ever-lasting learning can be achieved with simulations based activities in science education.

Learning achievements are the things that have been achieved in the mastery of specific skills in certain learning, where it will change the student's behavior and its change is relatively fixed [5]. The measurement of chemistry learning achievement of the students in this study was carried out in both experimental and controlled classes. The instrument used in this research was learning achievement test of 40 multiple choice questions which have been tested for validity and reliability.

The average number of chemistry learning achievement of students in the experimental class was higher than that of the students in controlled classes. It showed that the teaching-learning use virtual chemistry laboratory integrated hybrid learning and traditional hands-on laboratory was more effective to be applied in the chemistry teaching-learning process on thermochemistry in Senior High School in Magelang Regency grade XI at the academic year 2017/2018. It is because in the teaching-learning use virtual chemistry laboratory integrated hybrid learning and traditional hands-on laboratory, learners can visualize and interact with the symptoms that will be experienced when conducting experiments in hybrid learning laboratories can be done independently by students, learning can be carried out more effectively and efficiently, and able to increase accessibility, because with hybrid learning students increasingly easy to access learning material.

Based on the result, it can be concluded that the teaching-learning using virtual chemistry laboratory integrated hybrid learning on thermochemistry implicates that simulations prepared and used throughout the study had an instructional characteristics with positive contribution to education and improved students’ chemistry learning achievement towards lesson at Senior High School in Magelang Regency grade XI at the academic year 2017/2018. Results of this study supported several research results reported in the related literature in which it was claimed that virtual chemistry laboratory integrated hybrid learning combined traditional hands-on laboratory enriched with simulations has many advantages on increasing students’ chemistry learning achievement. Thus, it can be reached a conclusion that the material developed and used in this study increased the students’ chemistry learning achievement level by creating an entertaining learning environment.

4. Conclusion

The conclusion of this research was there is a significantly different in students’ learning achievement among the three classes EG (class using both chemistry virtual laboratory integrated hybrid learning and
traditional hands-on laboratory), CG-1 (class using virtual chemistry laboratory integrated hybrid learning only) and CG-2 (class using traditional hands-on laboratory only) to the subject matter of thermochemistry concept. More research needs to be done to determine virtual chemistry laboratory integrated hybrid learning as a supplement for more traditional hands-on laboratory experiences.

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