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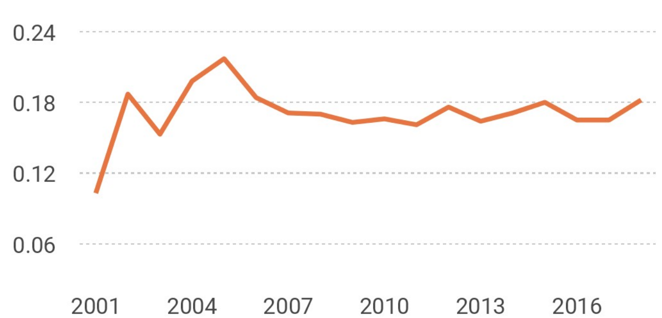

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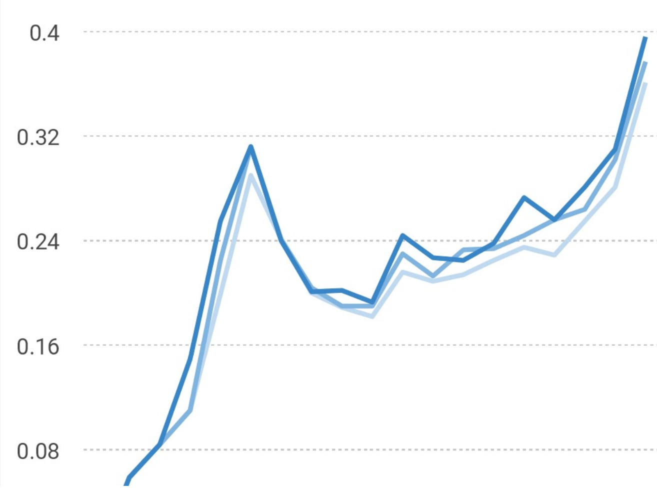

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The Measurement of Self-Efficacy in the Use of VICH-LAB in Electrochemistry

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Abstract. A virtual laboratory known as VICH-LAB (Virtual Chemistry Laboratory) has been developed in hybrid learning. This VICH-LAB was used in electrochemistry classes involving much practice work with various tools and materials. VICH-LAB contains a MSDS (Material Safety Data Sheet), tools introduction, interactive practicum, and assignments. The aim of this study was to measure self-efficacy in the use of VICH-LAB. The design of this research was quasi-experimental with a post-test design. Differences among 3 classes with different treatments was observed. The first class used a wet laboratory, the second class used a virtual laboratory integrated hybrid learning approach, and a third class used both of them. All three classes took place during the same academic term and had the same teachers. The variable measured in the three classes was self-efficacy, measured with a questionnaire consisting of 22 items. Self-efficacy scores were significantly different between the class using a wet laboratory and the class that was using the wet laboratory and VICH-LAB as a supplement.

Keywords*:* Electrochemistry, hybrid learning, self-efficacy, virtual laboratory.

INTRODUCTION

The new national curriculum demand is student-centered learning. Students must be active in learning so that they gain experience directly. This requires the teacher to innovate in each lesson. Teacher innovation is useful so that students do not feel bored in doing learning activities. The innovative practices include group discussion, games-based learning, giving problems to be solved by students, as well as other activities that make students more interested in the learning process.

Activities can be developed in chemistry classes that increase students' interest in learning about chemistry. Innovation can also be employed in student practicum activities. In chemistry classes, a practicum is an activity that helps students gain experience directly. Lab practica serve to increase students' knowledge in using chemical tools. These practicum activities should delve into the topic in more detail than in the classroom. Practicum activities that should be in line with the learning topic are scheduled separately only due to time constraints during classroom learning. However, the time constraints are the reason for teachers to have separate practica. Unfortunately, this approach can make it more difficult for students to understand the material. Ideally, lectures and practica should be combined.

Not all schools have practica in chemistry classes. Chemical tools and chemicals that are relatively expensive cause some schools not to make it as part of the class. This leads the teacher to demonstrate in front of the class and

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find a practicum video to provide students with experience. However, such experiences are only visual. Students do not conduct their own activities. The comprehension of students who practice directly will be different from the comprehension of students who only see what is being presented.

On the other hand, the development of technology has made it easier to attract students' attention in teaching-learning activities. Among the technological approaches used are learning by using the media, the existence of e-rapport, and so forth. The technology used in education is an effective method.[1]

Some researchers have sought to develop products that can facilitate students in learning, especially in practica. One example is a virtual laboratory. It is an alternative practicum without using the actual tools and materials. A practicum using a virtual laboratory can make efficient use of expensive chemicals. These laboratories are accepted and easy to use by various groups, and students can upload and download existing practica in a developed virtual laboratory.[2] However, a virtual laboratory is not an actual laboratory experience, and the difference can be particularly important when it comes to handling tools and chemicals.

The learning models in chemistry are varied. Many learning models have been developed by many experts. Learning model contains a way to conduct learning activities for material to be delivered. The learning model that many researchers have now developed is a hybrid learning model. The hybrid learning model is a learning model where the learning process is not only done in the classroom and with a face-to-face course but also by using online learning, and the latter component of the class can be done anywhere as long as it is linked to the internet. Research has found that the attitude of learners toward hybrid learning is very positive and they are generally satisfied with their learning experience.[3] Blended or hybrid learning makes learners more interested in learning. They assume that learning can be done flexibly. Hybrid learning requires tools for students and teachers to connect. Usually, researchers use moodle type software that is used as a means to conduct hybrid learning online.[4]

Virtual chemistry laboratories can develop students' abilities. They facilitate development of the ability to use chemical tools, improve student achievement, and develop scientific thinking skills.[5] In addition, the use of virtual laboratories can improve students' self-efficacy in laboratory work. Self-efficacy is seen in this work in the laboratory.[6]

Self-efficacy is a person's belief in their ability to succeed in a specific task or situation. Self-efficacy involves several aspects.[7] These aspects are the choice of activity, effort, persistence, achievement, learning and strategy orientation.[8,9] These aspects can be seen to measure the degree of self-efficacy of a student. These aspects were then developed into indicators to create self-efficacy questionnaires. Students with higher self-efficacy beliefs usually will choose difficult and challenging tasks/activities, expend great effort to complete the task in the time period that has been provided, persist in the face of a difficult task/situation to the end despite many hurdles. Moreover, experiences have been gained in carrying out learning activities, being confident in completing the task, and having better learning achievement than learners with low self-efficacy, and using strategy in every settlement and in carrying out learning.[8-12]

Thus, a virtual chemistry laboratory can be used to observe a student's self-efficacy. The previous research states that virtual labs are as effective as regular labs, and is important to support the practicability with time, tools and materials.[13,14]

MATERIALS AND METHODS

Sample and Procedure

The research was conducted at a public senior high school in Bantul, Yogyakarta. This school has grades 10, 11 and 12. Each grade has 7 life science classes and 2 social science classes. Participants in this study were from grade 12. This choice was made because the subject matter, that is, electrochemistry, was for grade 12. The seven life science classes were considered equal because the schools divided the students randomly at the beginning of the school year. Three classes were used for the research. The sampling technique was cluster random sampling.

One of the classes, Science 4, served as the control class (CG), the class that was using the wet laboratory as usual. The second class, Science 2, served as the first experimental class (EG-1); the virtual laboratory was substituted for the wet laboratory. The third class, Science 5, was the second experimental class (EG-2), and used both a wet laboratory and a virtual laboratory. All three classes had the same amount of learning time and same teacher. Face to face class periods were all allotted the same amount of time. Online learning was conducted in 1 hour sessions. CG and EG-1 online lessons were used for frequently asked questions, while for EG-2 online sessions were used for practica through virtual laboratory and frequently asked questions.

Research Design

This research used a quasi-experimental method with a post-test only design. Initial data for sampling used the original score of the previous chapter; that was the colligative solution. The self-efficacy questionnaire was given at the last meeting before the post-test. The research design is shown in Table 1.

TABLE 1. Research design

Classes	Treatment	Post-test
CG	T1	A1
EG-1	T2	A1
EG-2	T1 + T2	A1

Notes: T1 = wet laboratory, T2 = VICH-LAB, A1 = self-efficacy questionnaire

Variables and Measures

The variable measured in this study was the student's self-efficacy. The measurement of self-efficacy used in this study, which was administered after the treatments, was a questionnaire consisting of 22 items pertaining to choice of activities, effort, persistence, achievement, and learning and strategy orientation.[8-12] This questionnaire was adapted from those found in several books and journal articles on self-efficacy. The questionnaire was validated by a psychologist before being used in research classes. From the expert validation, the questionnaire was validated to the similar students that are not as the samples.

Data Analysis

Expert validation consisted of a theoretical validation using a validation sheet with a 3-point response scale—3 for essential, 2 for useful but not essential, and 1 for not necessary.[15] Data were ued to calculate Aiken's V with the formula.[16]

$$V = \frac{\sum s}{[n(c-1)]}$$

Notes: s = number given by rater – minimum validity scale or maximum validity scale – number given by rater, n = number of the rater, c = number of scale.

Empirical data were used to determine the reliability of the questionnaire and identify invalid items. Good reliability was equal to or more than 0.70. Items that were deemed invalid were not used in the test for the research class. An analysis of variance was conducted to test the significance of differences between the three groups in self-efficacy.

RESULTS AND DISCUSSIONS

The self-efficacy questionnaires used in the study have been empirically validated and examined by a psychologist with expertise in self-efficacy research. Our expert indicated that the self-efficacy questionnaires were valid and suitable for use with some revision. Of the 30 items, there were 6 items that the expert considered unfit for inclusion in the questionnaire. After these 6 items were eliminated, the resulting 24-item self-efficacy questionnaire was given to students outside the research class for empirical validation. The total number of respondents who completed this questionnaire, who came from two other schools, was 279. The reliability of the self-efficacy questionnaire proved adequate (α= 0.71). This reliability states that the questionnaire has been reliable to use. The validity of fit item was more than 0.77 and less than 1.30. The empirical validity can be seen in Figure 1.

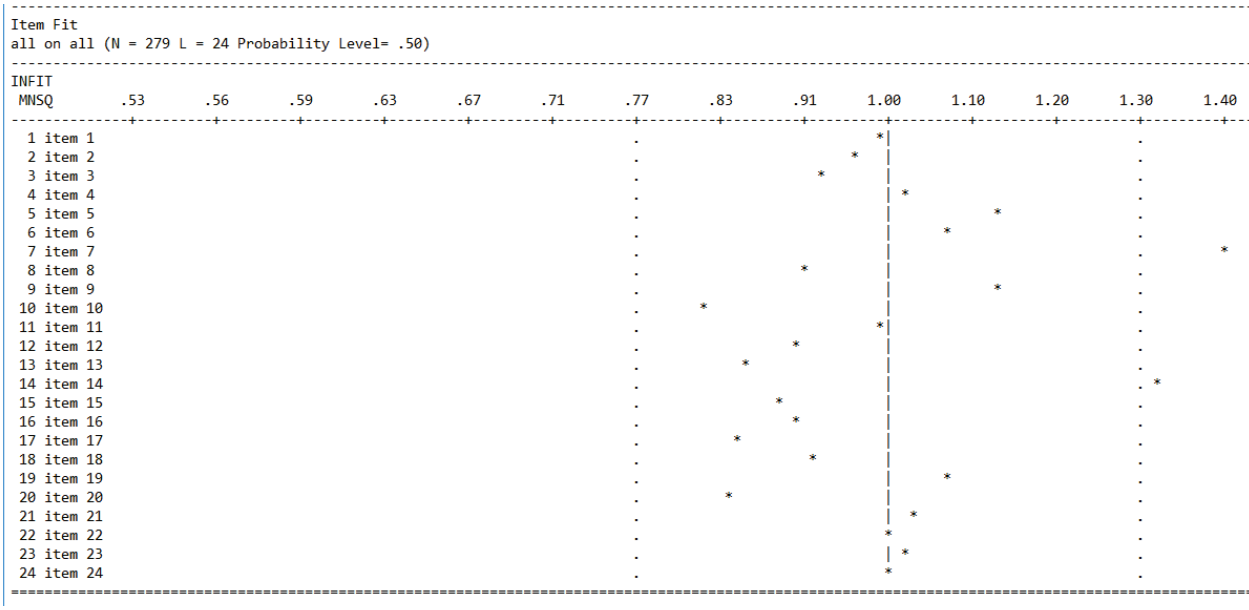

FIGURE 1. The result of empirical validity

The result of the empirical validation was that 2 items were insufficiently correlated with the total score, and thus 22 items were included in the final self-efficacy scale, which was then administered to the three classes in the study. The means for each class are shown in Figure 2.

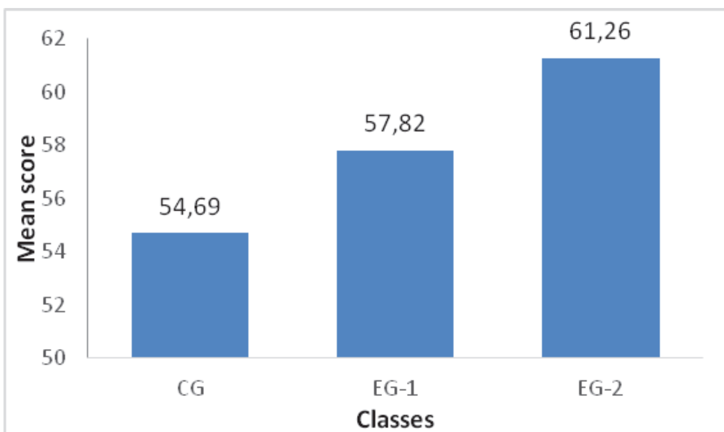

FIGURE 2. Graph of score mean

Figure 2 showed that the use of VICH-LAB as supplements (EG-2) produces a score mean greater than the other classes (CG and EG-1). The VICH-LAB only group (EG-1) had a higher average score than the wet laboratory (CG) group. An analysis of variance (ANOVA) was performed on these group differences.

TABLE 2. Test of homogeneity of variances (Self-efficacy)

Levene Statistic	0.788
df1	2
df2	87
Significance	0.458

A test of the homogeneity of variances found that the significance value (0.458) was greater than the threshold p-value of 0.05. This suggests that the variances of the self-efficacy scores for the three classes were homogeneous as shown in Table 2. A posthoc test indicated that the CG (wet laboratory) and EG-2 (wet laboratory + VICH-LAB as a supplement) groups were significantly different in self-efficacy, $p < 0.006$. The other comparisons did not yield significant differences.

Self-efficacy is both a cause and an effect of success in the classroom. Students who have high self-efficacy will achieve satisfactory learning outcomes and vice versa. In addition, students with high self-efficacy also always take full responsibility for doing all the things necessary for effective learning. Students vary greatly in their level of self-efficacy. Even students with equally high grades do not necessarily have equally high levels of self-efficacy. In this study, the variable measured favored VICH-LAB treatments as supplements. It might be because classes with 2 different laboratory types gain more knowledge than classes with a single type of laboratory. CG and EG-1 get practice using only 1 laboratory, CG with wet laboratory, and EG-1 using VICH-LAB. A wet laboratory practicum takes more time than a virtual lab. It may be that students who do poorly in a time-consuming lab assignment will be less likely to keep working hard in the labs. Theory makes no predictions in this regard. CG students gain skills in using chemical tools. Students in EG-1 whose practicum includes using a VICH-LAB can repeat the practice that they did, and the practicum is designed in accordance with existing theories. However, students in this class will not gain experience in lab work in real laboratories. Thus, there are both weaknesses and advantages to this approach. From the analysis, the EG-1 and CG classes, who each participate in only one type of lab, are not significantly different. EG-2 students get 2 different laboratories. At school, students get hands-on experience in the laboratory and out of school, students can practice virtually. This class more benefits than any other classes. The students who had both types of practicum experience more strongly remembered the principles of the practicum. This makes the EG-2 students become more familiar with the material being practiced. This understanding may lead to a higher level of self-efficacy for the EG-2 students.

The incorporation of technology is an important recent innovation in education. The use of a VICH-LAB as a supplement is an example of the benefits of technology use. This VICH-LAB works like a game. Students do it themselves with the instructions. The contents of this laboratory can enable students to visualize the practicum that they have done in a real laboratory. This visualization will not be obvious when using real practice materials. Changes that occur in the actual practicum happen very quickly and are often missed by the students.

A previous study found that the virtual and wet laboratory groups did not have a significant difference. This study compares the use of a virtual laboratory with a wet laboratory in electrochemistry class. A virtual laboratory is used instead.[13] This makes the researchers have to rethink the use of the virtual laboratory. The innovation of this research was using a virtual laboratory as a support or supplement rather than as a substitute for real-life lab work. This allows students to experiment twice. First, students conduct experiments at school using a wet laboratory, and then conduct experiments at home using a virtual laboratory. Both have the same principle but there are differences in the chemicals used.

Previous study has found that simulated-based learning can influence students' motivation.[17] Students' motivation in learning affects students' self-efficacy. Another study shows that the use of virtual laboratory can improve self-efficacy in laboratory work.[6] In the current study, the use of virtual laboratories as a supplement was found to to improve students' self-efficacy in the chemistry lab. For that in the implementation of this VICH-LAB, practicum performed virtually can add insight and student experience even virtually. Through a virtual laboratory, all students can do their own practicum.

CONCLUSIONS

The conclusion of this study is that a class using VICH-LAB and wet laboratory (EG-2) is significantly different in self-efficacy from a class using wet laboratory alone (CG). However, neither class differed from one that used only VICH-LAB (EG-1).

The use of VICH-LAB as a supplement can be used as an alternative in conducting the practicum-based learning process. Of course, this VICH-LAB is used to support the wet laboratory. Both are used simultaneously in the process of deepening the material. Students will gain both practical experience in using chemical equipment and the benefits of the visual experience of VICH-LAB. However, if VICH-LAB is used as a substitute for the wet laboratory, it will not have a good effect on the learning process. The results of this study inspire great hope for the future use of virtual laboratories, especially in science subjects such as chemistry. We will discuss this further in another chapter.

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