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RESEARCH PAPER

Using Virtual Laboratory: A Profile of Students' Self-Efficacy on Electrochemistry

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Abstract: This study aimed to analyze the profile of students' self-efficacy in the use of virtual laboratory in electrochemistry class. It is quantitative descriptive research. The total subject of this research was 90 students from grade 12th public senior high school. Three classes were selected randomly to determine the sample: C class using conventional laboratory, E-1 class using virtual laboratories as a substitute, and E-2 class using both a virtual laboratory as a supplement. The instrument was a self-efficacy questionnaire that consisted of 22 items. The data were analyzed and categorized into 5 rating categories: very high, high, fair, low, and very low. The results showed that the profile of students' self-efficacy in the E2-class was highest than in 2 other classes.

Keywords: electrochemistry, a profile, self-efficacy, virtual-laboratory

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INTRODUCTION

The development and use of technology in chemistry education are very diverse. The use of technology in chemistry education makes it easier to do things. The use of this technology positively affects students [1]. Examples of it are using power points in explaining material to students. Powerpoint helps teachers explain without bothering to write on the board. Using technology as a learning medium can help students achieve their goals [2].

The implementation of technology currently being developed in the learning process is hybrid learning. This mode is a blend of face-to-face learning in the class with online learning outside the classroom [3]. This mode transforms the traditional learning process into a modern learning mode [4]. In Indonesia, this learning approach is still rarely used. Learning by using this mode makes students more interested [5]. It is because online learning involves the smartphone or laptop they have. Learners know that this device is not only used for playing games or chatting. The interest of these students makes their values better. Online learning can help students improve their cognitive value [6]. Besides, hybrid learning modes can reduce limited educational costs [7]. Its method also makes it easier for students to access learning from a distance, provided there is internet [8].

A virtual laboratory is a medium for conducting practicum without using tools and chemicals. Media like this are digital-based learning media that use smartphones or laptops to do lab work. Virtual laboratories are a type of simulation and game media. Operational simulations are designed to teach procedural abilities, while conceptual simulations focus on concepts and knowledge strategies [9]. Learning with this simulation can increase learning motivation and interest in learning and make students active in the learning process [10]–[12]. In addition, this laboratory can also improve

student learning outcomes and confidence in science learning [13]–[17]. Practices like this do not require a long time. Virtual laboratories can overcome the limitations of time in teaching material. Practicum is virtually an inquiry setting with educational value [18], [19]. The use of virtual laboratories is accessible anywhere and anytime and can reduce the budget for learning [20]. This laboratory allows students to observe things that cannot be observed during real lab work [21].

Internet-based technology, such as virtual laboratories and hybrid learning, can also positively influence student self-efficacy [22], [23]. Self-efficacy is a person's belief in conducting learning activities in the classroom. A student's self-efficacy will be different from the self-efficacy of other students. Students with high cognitive abilities do not guarantee high self-efficacy and vice versa. This self-efficacy consists of 6 aspects: choice of activity, effort, endurance, learning, achievement, and strategy orientation [24]–[28]. These six aspects are used to measure students' self-efficacy in using virtual laboratories.

Students with high self-efficacy can manage their activities and choose the challenging task they can finish [24-25]. They feel challenged by the difficult task given by the teacher and are always eager to choose their learning activities [27]. They spend their time very well in their effort and try hard to complete the task [25], [26]. They try their best to get the task done on time or before. They use their time and energy well.

Even though there are challenges, they will survive difficult conditions until the end of time [24]–[28]. They will face challenges and obstacles with full force. In the learning, they use the experience they had gotten previously [24]. It is used if there are events that have previously happened to be done properly.

Students with high self-efficacy are more confident in completing tasks and have good learning achievement than students with the same knowledge but lower self-efficacy [24]–[28]. The beliefs that people have will be different. Their self-efficacy will not be the same for two people who have the same abilities and knowledge. There are lower and higher. They use strategies in each settlement and learn [24]–[26].

MATERIALS AND METHODS

This research aims to analyze students' self-efficacy profiles in using technology in learning, especially in virtual laboratories and hybrid learning. It is quantitative descriptive research with 90 students' from 3 classes. They were students in grade 12th from one of the public senior high schools in Yogyakarta (Region in Indonesia). Three classes were selected randomly from 6 regular classes in this school. First-class was called C-class, using a conventional laboratory with really chemicals and tools. The second one was E1-class using a virtual laboratory as a substitute, and the last one was E2-class using both of them. In the school. They practiced in a conventional laboratory, and outside of school time, they practiced in a virtual laboratory. The teacher and learning time was similar. It is a hybrid learning. Outside of school time, the time for C and E1 classes was used for question and answer, while for E2 class was used for practicum virtually and question-answer. The extra time was equated to making a balance for the three classes. The research design was a post-test-only control group design. The self-efficacy questionnaire was given in the last meeting.

The instrument that was used was a questionnaire with 22 items. It was developed by the researcher in a previous study [29]. The instrument was adapted according to the research situation. It was valid and reliable in an expert judgment and empirical validation. The expert is a psychologist. The items were synthesized from 6 aspects: choice of activity, effort, persistence, learning, achievement, and strategy orientation [24]–[28]. It used a four scale that was Likert modification. The data analysis consisted of 2 types. There are average scores for all items and the average score in each aspect for the three classes. The score was converted into 5 rating categories: very high, high, fair, low, and very low. Table 1 was a guideline to convert this score [30].

Table 1. Guideline 5 Categories

Score Range	Category
$X \geq 3.25$	Very High
$3.25 \leq X < 2.75$	High
$2.75 \leq X < 2.25$	Fair
$2.25 \leq X < 1.75$	Low
$X < 1.75$	Very Low

RESULTS AND DISCUSSION

The profile of students' self-efficacy in virtual laboratories has been analyzed. The analysis of this self-efficacy has two parts. The first part compares the average scores of all items, and the second part compares the average scores of each aspect and each class. A comparison of the average scores of all items is described in Figure 1.

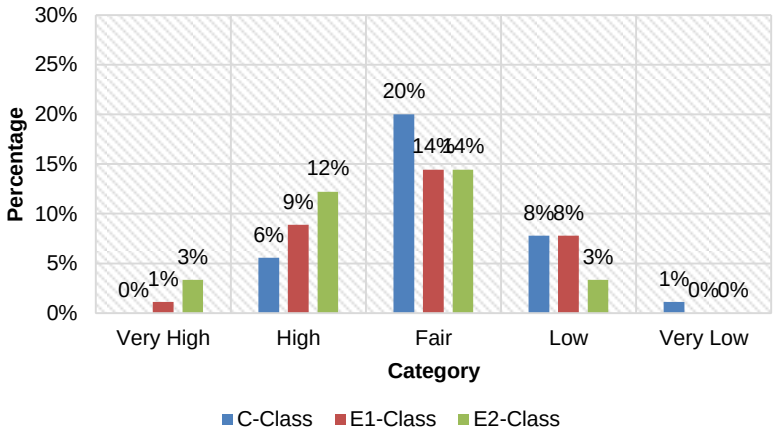

Figure 1. Result of Total Score in Three Classes

The percentage of students is divided into five ideal categories. The percentage above shows that the E2-class is dominant in the very high and high categories. Meanwhile, C-class is more dominant than the other two classes in the fair category. The other two classes in this category are not much different. E2-class has a smaller percentage at low criteria than the other two classes. It shows that using virtual laboratory media as a supplement can increase students' self-efficacy. All three classes have the same learning time as hybrid learning. The difference is only in the laboratory used.

A hybrid learning is a learning model that combines online learning with face-to-face learning in the classroom. This mode is used as distance learning. Utilizing this learning mode, students can access or take part in learning anytime and anywhere. Online learning modes have two types, namely synchronous and asynchronous modes. Synchronous mode is learning that is carried out simultaneously or between students and teachers having interactions simultaneously. Meanwhile, an asynchronous mode is online learning which can be accessed at different times. Previous studies reported that the use of a combination of synchronous and asynchronous could make successful learning for teachers and learners [31].

Online learning is carried out at home using chat applications and a virtual laboratory. Using a virtual laboratory as a supplement can support practical work in a conventional laboratory. Both use different chemicals but have the same principles. The advantage of this virtual laboratory is that each student can do their practicum on their foreign gadget. It does not happen in conventional laboratory use, which a few students only do.

The second part compares the percentage of the three classes with describes each aspect. The percentage comparison of the choice of activity aspects can be seen in Figure 2.

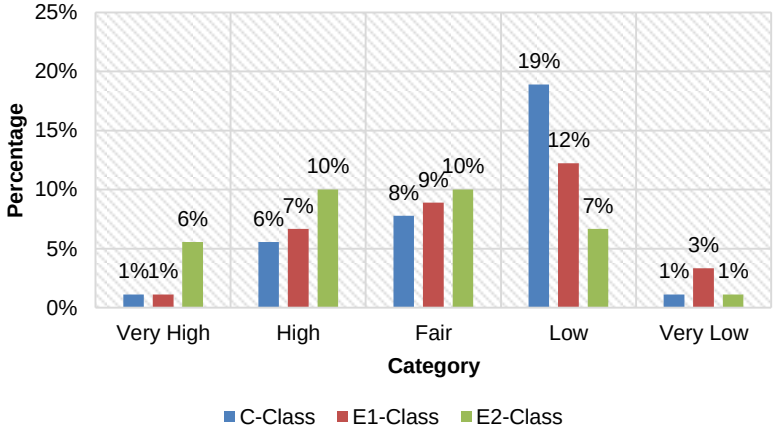

Figure 2. Comparison of Activity Choice Aspect

The figure above shows that E2-class students dominate in the very high, high, and fair categories. In the low category, C-class students are more dominant than the other two classes. The percentage difference between the E2-class and the other two classes is too far in the very high category. The most significant percentage is C-class students in the low category, and the dominance of E2-class is in the very low category.

The dominance of the E2-class in the three highest categories is because the use of technology in learning makes them interested in learning and deeper into this material. The choice of activities is one aspect of assessing students' self-efficacy. Students with a high level of self-efficacy will choose difficult and challenging tasks that are considered to be completed [24]–[28]. Most E2-class can choose assignments and activities with confidence and manage them independently. In terms of challenges, students of this class like activities that challenge and stimulate their adrenaline. They believe that challenging tasks can be completed well.

It is inversely proportional to the students of C-class and E1-class. Nearly half the E2-class students are in a low category, and more than half of the C-class students are in a low category. Students of both classes have a low level of self-efficacy. They will choose easy activities according to their abilities. Besides, when they were given a slightly challenging task, they were hesitant about completing it.

Learning with virtual laboratories and hybrid learning has activities that can make students more interested and complete. These results are consistent with previous research. According to him, students with high self-efficacy choose difficult activities [32]. This self-efficacy positively impacts activities and learning outcomes [33]. This belief is proof that they understand their abilities.

The second aspect is the business aspect. The comparison of the percentage of each class in the effort aspect can be seen in Figure 3.

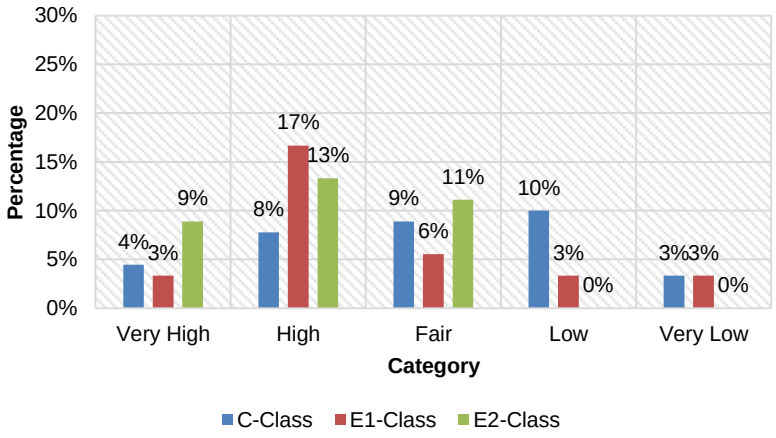

Figure 3. Comparison of Effort Aspect

In the effort aspect, the self-efficacy of E2-class students is evenly distributed in the very high, high, and fair categories. None of the students in this class are in the low and very low categories. Meanwhile, the students' self-efficacy in the other two classes was spread over five categories. Even though the E1-class is dominant in the high category, there are still students in this class who are in the low and very low category. C-class students' self-efficacy was evenly distributed across all categories.

Students with high self-efficacy will have the effort to complete their assignments with all their might within the time provided [24]–[28]. Such students always complete projects on time or even faster. Besides, they will go to great lengths to complete challenging tasks. They tend to maximize the time allotted to complete it.

E2-class students do laboratory work two times in each practicum sub-chapter, in a conventional practicum in school and a virtual practicum in the house. Meanwhile, C-class students only do a conventional practicum, and class E1 students only do practicum virtually. It makes E1-class students have more effort in carrying out chemistry learning, especially in practicum. Students of this class will also be more active in their learning. Students in this class have more questions that need to be asked, so the interaction between teachers and students is more. However, all three classes have the same learning time. Students in C-class and E1-class during online learning only

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questions and answers. This activity was not used much by them in finding out. This study also follows previously reported studies that high self-efficacy will make more effort than low self-efficacy [32]. Meanwhile, other research states that online learning can make students active [34]. Figure 4 shows the percentage comparison seen from the persistence aspect

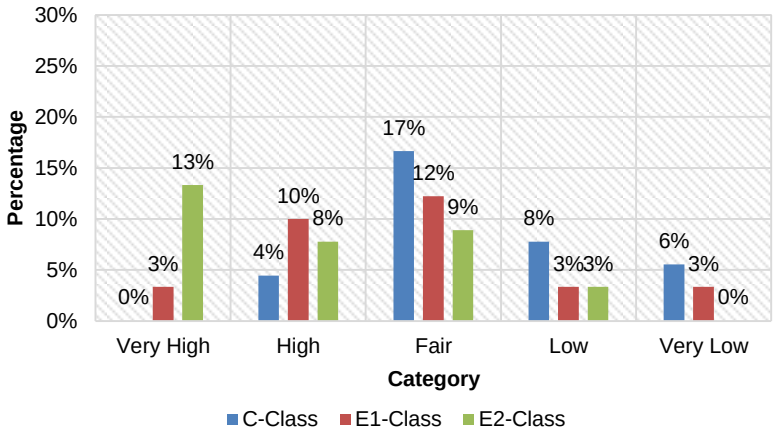

Figure 4. Comparison of Persistence Aspect

In the figure above, the self-efficacy of E2-class students is more dominant in the very high category, and the others are spread over three other categories. None of the students in this class are in the very low category. While E1-class students 'self-efficacy was dominant in the high category and C-class students' self-efficacy was more dominant in the fair category. The self-efficacy of C-class students is not in the very high category. It shows that the E2-class students' self-efficacy is better than the other two classes.

Compared with students with low self-efficacy, students with high self-efficacy can withstand difficult tasks or situations until the time is over [24]–[28]. Students with high self-efficacy will solve all the obstacles and problems they will face. Their persistence is very high in achieving the target that they previously set. This target becomes their goal in completing the task. Conversely, students with low self-efficacy will easily give up when given problems or obstacles. Even though they already have a target, that is not their goal. Students like this have limited effort and are easily discouraged in their journey.

Students' self-efficacy in E2-class has high persistence in completing the chosen assignment or activity. Before completing, they already have a target for this task to be completed on time. Students of this class do not give up easily. They do a lot of things to maintain their principles. In class, students are doing laboratory work using two laboratories. When they do a practicum, there are many things they can get, including the effort to complete the task persistently and not easily give up. It is in line with previous research that students with self-efficacy make them have high persistence [32], [35]. Meanwhile, students can use technology-based learning [36]. Figure 5 shows the percentage comparison seen from the learning aspect.

Figure 5 shows the students' self-efficacy of E2-class dominance in the very high and fair categories. The percentage in the category is quite much higher than the percentage in each category. Meanwhile, there were still a few students in this class in the very low category and none in the other two categories. C-class students are dominant in the very low category, and E1-class is prevalent in the fair category. When viewed from the fair, high, and very high categories, the students' self-efficacy in E2-class is higher than in the other two classes.

Students with high self-efficacy will use the experience they get to carry out their learning Activities [25], [26], [28]. Good or bad experiences are used as learning for a better process. It is different from students with low self-efficacy. The experiences they have gained are only used as a pastime, not in the next learning process. Learning using technology provides a special attraction for students. When doing a conventional practicum, students feel bored. It is because not all students can do the practicum. Practical activities are limited to chemicals and learning time.

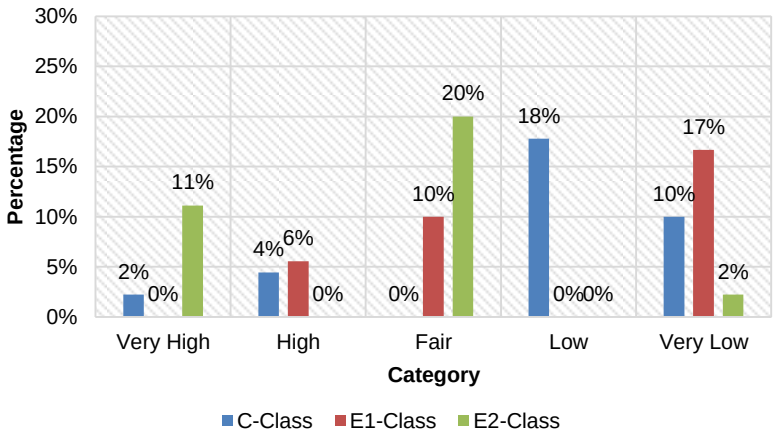

Figure 5. Comparison of Learning Aspect

Meanwhile, when using technology as a virtual laboratory, students are more interested in learning. It is following previous research that learning using technology positively impacts students [33]. This impact can be in the form of learning outcomes and good attitudes. Figure 6 shows the percentage comparison seen from the achievement aspect

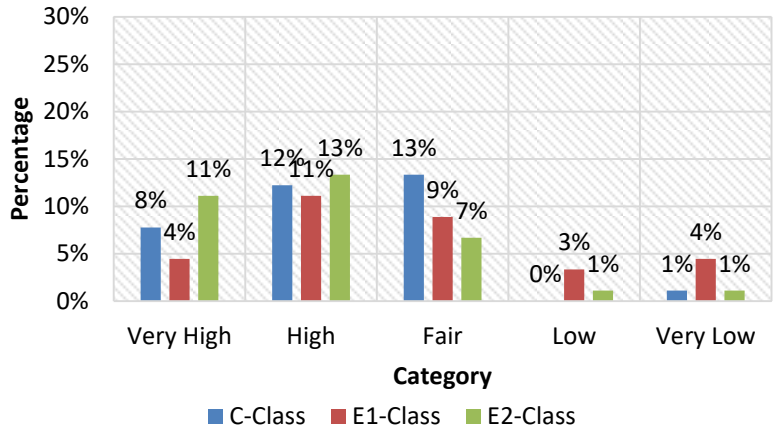

Figure 6. Comparison of Achievement Aspect

In the achievement aspect, the students' self-efficacy in the three classes was almost evenly distributed in the very high, high, and fair categories. Only a small proportion are in the low and very low categories. The students' self-efficacy of E2-class dominates in the high and very high categories. In this category, more than half of the E2-class had high self-efficacy. Although there is only a slight difference between the two classes, in the high category, students in E2-class are still high. Whereas in the fair category, C-class students dominate more than other classes.

When there are two students with the same cognitive abilities but different levels of self-efficacy, students with high self-efficacy are confident in completing tasks and have good learning achievement compared to low self-efficacy [24], [26], [28]. Students with high levels of self-efficacy believe that they will achieve satisfactory learning outcomes. It is inversely related to students with low self-efficacy.

Students of the E2-class have more practical experience than the other two classes. Because it is done repeatedly, this makes it easier for E2-class students to understand the principles of the practicum that has been done. Their belief follows the students' understanding of this class in the achievements they will achieve later. They are sure that they will get the best results because of their efforts.

Learning using technology has a positive effect on self-efficacy. Self-efficacy has a good relationship with the achievements to be achieved. The achievement of students with high self-efficacy was greater than that of students with lower self-efficacy. E2-class students have higher self-efficacy compared to other classes. It shows that E2-class has a higher achievement than the other two classes. This statement is supported by several previous studies that show self-efficacy and achievement have a good relationship [23], [37]. Also, students with high self-efficacy have higher achievement than those with lower self-efficacy [32]. Figure 7 shows the percentage comparison seen from the strategy-oriented aspect.

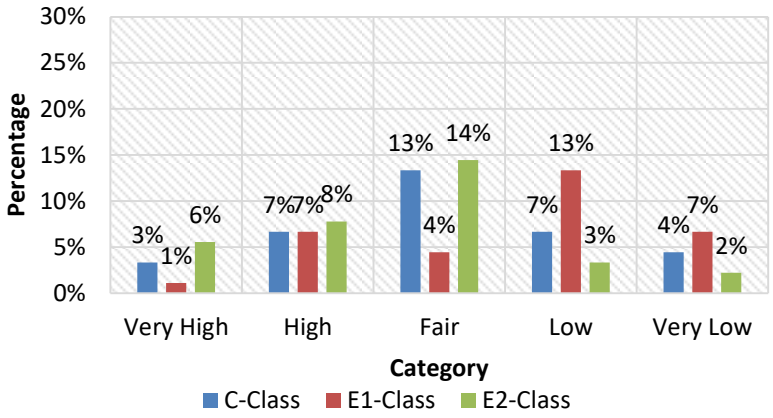

Figure 7. Comparison of Strategy-Oriented Aspect

The last aspect is the aspect of strategic orientation. E2-class students dominate in the very high, high, and fair categories. Meanwhile, only a small proportion are in the low and very low categories. Both of these categories were dominated by E2-class students. In the very high, high, and fair categories, the percentage of students in E2-class and C-class does not differ much. Practicing practicum using conventional laboratories must have a strategy so as not to waste chemicals and to learn time. It does not apply to practicums with virtual laboratories only.

Students with high self-efficacy always use strategies to solve problems and in carrying out learning [24], [25], [28]. The strategy used by these students also varies, including studying regularly, doing assignments well in advance of their due date, and also being able to choose a learning method according to themselves. With this high self-efficacy, students will get maximum learning outcomes.

This E2-class student has a high strategic orientation. They implement the strategy in activities during hybrid learning, both offline and online. The orientation towards this strategy makes students in this class more active in participating in-class learning. In contrast, the other two classes have a lower strategic orientation.

CONCLUSION

From the discussion of this self-efficacy profile, it can be concluded that students by learn using technology, especially virtual laboratories as supplements, have higher self-efficacy than other classes. In terms of 6 main aspects, most students' self-efficacy was spread into very high, high, and sufficient categories. Meanwhile, only a small proportion of students in this class are in a low category.

In future research, a broad self-efficacy profile analysis can be carried out. It is helpful so that teachers can find out the shortcomings of each student, especially regarding self-efficacy in learning in the classroom.

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