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Promoting Students' Learning Independence and Achievement Through the Use of Virtual Chemistry Laboratory in Blended Online Learning

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Abstract : Since the laboratory work activity is an essential part of chemistry learning, recent studies on the effectiveness of Virtual Chemistry Laboratory (VICH-Lab) are proposed. This research aims to promote students' learning independence and achievement by implementing VICH-Lab in blended online learning of chemical equilibrium topics in a chemistry lesson. Quasi-experimental research with a post-test-only design was implemented in this research. The samples of this research cover two classes drawn from a public secondary school in Kulon Progo Regency, Indonesia. Both classes were established by the cluster random sampling technique. The students' learning independence data were collected through the Learning Independence Questionnaire (LIQ) and Observation Sheet of Learning Independence (OSLI). In contrast, the data on students' achievements were obtained through Chemical Equilibrium Test (CET). The two data types were analysed following the one-way Analysis of Variance (one-way ANOVA) technique. The analysis results indicate any significant effects of VICH-Lab in blended online learning on students' learning independence and achievement.

Thus, the VICH-Lab in blended online learning can be used as an alternative way to promote students' learning independence and achievement, especially in this pandemic covid-19 situation.

Keywords : blended online learning; chemical equilibrium; students' learning independence; students' achievement; virtual laboratory

1. Introduction

As the times progressed, all of the fields in daily life rapidly developed, including the educational field. The sole purpose of education is as a direction to be addressed in realizing an excellent learning process, both inside and outside the classroom. In the field of education, students require to determine the information and consider the interactions with their environment independently. Daryanto (2013) states that environmental concepts in the educational process include the learning places, methods, media, appraisal systems, and necessary facilities to make the easiest way for students to experience teaching-learning instruction. In this kind of system, the teacher plays several roles, such as facilitator, mediator, and mentor. Thus, to meet these functions, the development of learning media is necessary to improve the quality of the learning process and makes

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interesting and effective learning activities (Wisetsat & Nuangchalerm, 2019; Porter, 2008). The learning media that should be widely used in the 21st-century learning system is the media with the integration of IT (Information Technology). The IT-based media can be used as an alternative way in every teaching-learning instruction, including chemistry learning.

The realisation of the use of IT-based media in chemistry teaching-learning instruction leads to the learning process that is not always conducted in face-to-face learning but also in the form of online learning. Blended online learning is a concept that includes a teaching-learning approach that combines both face-to-face and online learning (Musawi, 2011; Zhao & Breslow, 2013; Jahjouh, 2014; Lalima & Dangwal, 2017). Daryanto (2013) states that the online phase in blended online learning is not the primary learning mode, but it serves as complementary material to conventional face-to-face learning. Hence, blended online learning in chemistry subjects will combine the concept of learning inside the classroom, which refers to face-to-face learning and outside the school, which refers to online learning. The online phase of blended online learning provides an enriching learning time and materials that improve the interactions among students and teachers to produce positive learning outcomes as well as students' learning achievement (Fitriyana et al., 2018; Means et al., 2013).

In addition, as part of science subject, chemistry seeks the following questions about what, why, and how the natural phenomena are related to the composition, structure and properties, changes, dynamics, and energy. Hence, the presence of reasoning ability is necessary to understand the chemistry concepts (Priyambodo et al., 2021). The concept of chemistry is mostly related to the natural phenomena observed through an experimental activity. However, a lot of students often classify chemistry subjects as complex and challenging to learn (Sirhan, 2007; Sokrat et al., 2014; Woldeamanuel et al., 2014). The students' chemistry learning difficulties are caused by the characteristics of chemistry that are naturally abstract (Sirhan, 2007; Sokrat et al., 2014; Woldeamanuel et al., 2014), the multiple representations of the chemistry concepts (Sirhan, 2007; Salta & Tzougraki, 2004; Treagust et al., 2000), and low performance in reasoning skills (Coll et al., 2005; Woldeamanuel et al., 2014). Therefore, a laboratory work activity that can ease the students in understanding the nature of chemistry concepts is needed.

Phrased differently, since the technology has been developed rapidly that indicated by the appearance of blended online learning with its online instruction, the laboratory work activities could not only always be conducted in the hands-on laboratory but also in the form of the virtual laboratory (Ali & Ullah, 2020). The use of VICH-Lab is improving due to the increasing cost of hands-on laboratories (Hawkins & Phelps, 2013; Biader et al., 2002; Almazaydeh et al., 2016) and the shortage of well-equipped chemistry laboratories (Penn & Ramnarain, 2019). The VICH-Lab can be used to substitute hands-on laboratory work activities, especially in this pandemic covid-19 era, because of the urge for online learning activities implementation (Deepa et al., 2021). Recent studies, i.e., Woodfield et al. (2005) and Winkelman et al. (2020), have proven that VICH-Lab as a pre-lab session gave merits for students in subsequent real-world lab sessions. Furthermore, other studies suggested that VICH-Lab in a virtual world could substitute the real-world experiment (Hawkins & Phelps, 2013; Rowe et al., 2018; Winkelman et al., 2017; Winkelman et al., 2020). Therefore, we can say that conducting chemistry experiments in a virtual situation signified the same learning gains as well as for those students performing the real-world chemistry experiment.

In addition, this VICH-Lab can be accessed in two forms, offline and online learning instruction. The VICH-Lab was applied as a computer-based learning media, and it could be a solution to simulate experimental work about chemistry. Despite the advantages of VICH-Lab still debated, the results of Tuysuz (2010); Unnisa (2016); Latifah et al. (2019); and Winkelman et al. (2020) prove that the VICH-Lab media brings a positive influence on students' learning outcomes compared with the hands-on laboratory. Specifically, it promotes students' ability to recognize the laboratory equipment, the procedures of the experiment, and higher order skills (Diwakar & Noronha, 2016). It was confirmed that the role of the virtual laboratory could develop students' motivation toward chemistry learning (Ikhsan et al., 2021); attitudes (Winkelmann et al., 2020); research skills (Bortnik et al., 2017); and experimental self-efficacy (Winkelmann et al., 2014; American Chemical Society, 2017; Rowe et al., 2018; Kolil et al., 2020). However, the use of VICH-Lab in chemistry learning is rarely optimized and needs more emphasis on skill-based learning outcomes (Chan et al., 2021).

On the other hand, through the online phase of blended online learning, the students are free to use and repeat the experimental simulation anytime and anywhere they want. The VICH-Lab in blended online learning was IT-based media that emphasized students' learning development. Thus, it can be used to promote students' learning independence. Students' learning independence is essential in chemistry learning activities because students who have good independence in learning can construct knowledge and propose ideas. Thus, it leads to an increase of students' competencies and improves students' learning outcomes (Kulsum et al., 2017; Cahyana et al., 2019). Moreover, the students will play an active role in a teaching-learning situation in developing their knowledge (Boekaerts, 1997). Hence, the students could well manage their time, their learning, as well as their selves (Field et al., 2015). Varied teaching interventions have been proposed to increase students' learning independence, such as through the use of problem-based learning (Suyanta et al., 2019), critical analysis techniques (Danial & Yunus, 2019), and web-based learning (Cahyana et al., 2019). Further, the work of Kitsantas (2013) revealed that using technology as an innovative learning strategy could develop students' learning independence because it helps the students to monitor, implement, and evaluate learning activities in dealing with assignments (Mooij et al., 2014). In this context, the VICH-Lab that is closely related to web-based learning could be directing the students to be independent according to their competencies (Latifah et al., 2018; Wijayanti et al., 2019). The presence of innovative learning media of VICH-Lab in teaching-learning instruction brings a new learning environment to students and will attract students' motivation to learn independently. The more students learn independently, the higher achievement they will gain.

The improvement of students' achievement in this study could be achieved due to the presence of additional learning time and a flexible way of learning in the online phase of blended learning (Fitriyana et al., 2020; Fitriyana et al., 2021). The VICH-Lab in blended online learning could provide a virtual learning situation for students to promote an optimal learning environment for students (Rivera, 2016). Further, a higher performance of students is related to a well manage students in dealing with a task (Wilson & Narayan, 2016).

Therefore, this research seeks to determine the effects of VICH-Lab in blended online learning on students' learning independence and achievement. This is promising because the VICH-Lab provides effective and interactive media to supplement chemistry learning activities. While blended online learning brings additional learning time and learning material for students, it leads to flexible learning instruction (Fitriyana et al., 2018).

Problem of Research

The purpose of this study was to promote students' learning independence and achievement by implementing VICH-Lab in blended online learning of chemical equilibrium topics in a chemistry lesson. The VICH-Lab has been developed as an alternative experimental media in chemistry lessons. It contains an interactive simulation experiment in chemical equilibrium topics. This VICH-Lab can be accessed through an online phase of blended online learning in order to freely use and repeat the experimental simulation anytime and anywhere. The research problem guided this study as follows:

- Is there any significant difference in students' learning independence between students who integrated VICH-Lab in blended online learning compared to students who implemented the hands-on laboratory?
- How was the effect of VICH-Lab in blended online learning on students' learning independence?
- Is there any significant difference in students' achievement between students who integrated VICH-Lab in blended online learning compared to students who implemented the hands-on laboratory?
- How was the effect of VICH-Lab in blended online learning on students' achievement?

2. Methods

The methods for conducting this research are described in this section.

A. Research Design

This research was conducted on the chemical equilibrium topic of the chemistry lesson. Quasi-experiment research with a post-test-only control group design was implemented in this research. The independent variable is the effects of VICH-Lab in blended online learning. Meanwhile, the dependent variable was students' learning independence and achievement. Both dependent variables were collected after the research treatment had been implemented.

This research seeks the effects of VICH-Lab in blended online learning applied in the experimental group compared to the hands-on laboratory implemented in the control group on students' learning independence and achievement.The research design of this study is illustrated in Table 1.

Table 1: The Post-Test Only Design of The Research

Group	Treatment	Post-test	
		Learning Independence	Test on Chemical Equilibrium
Experimental	VICH-Lab in blended online learning	√	√
Control	Hands-on laboratory	√	√

B. Research Sample

All eleventh-grade students registered in the science program in all of the public secondary schools at Kulon Progo Regency, Indonesia were set as the population of this research. The sample covers two classes drawn from a public secondary school in that area. Both classes were established by the cluster random sampling technique. One class of 33 students (20 female and 13 male) was devoted as the experimental group which implemented VICH-Lab in blended online learning. In comparison, the other 32 students (22 female and 10 male) were set as a control group that executed the hands-on laboratory work. The two groups that participated in this research were ensured to have similar prior knowledge in chemistry. Moreover, the research sample in this study comes from a similar economic background (middle to low-end economic background), aged 15-17 years old, and in their second year of a total of 3 years of secondary school educational programme.

C. Research Treatment

The research treatment applied in the experimental class, which was the VICH-lab in blended online learning were conducted for five meetings teaching-learning activities. Since blended online learning is a learning mode that combines face-to-face and online phase instruction, thus the chemical equilibrium learning activities are performed both inside the classroom with face-to-face learning and outside the classroom with online learning instruction.

The first was learning activities in the classroom that were experienced in the form of face-to-face learning. The laboratory work was performed through VICH-Lab media of chemical equilibrium materials under the teachers' supervision. The VICH-Lab was provided in the Moodle. Therefore, the students can easily repeat the laboratory work as enrichment in chemical equilibrium learning outside the classroom. Instead of repeating the laboratory work outside the school as an additional learning time, other students' activities conducted online discussions. They reported the results of laboratory work activities they have perceived through the VICH-Lab. All of the outside classroom activities in this group were done with the online mode as part of blended online learning. The illustration of VICH-Lab that integrated with blended online learning in this research seen in Figure 1.

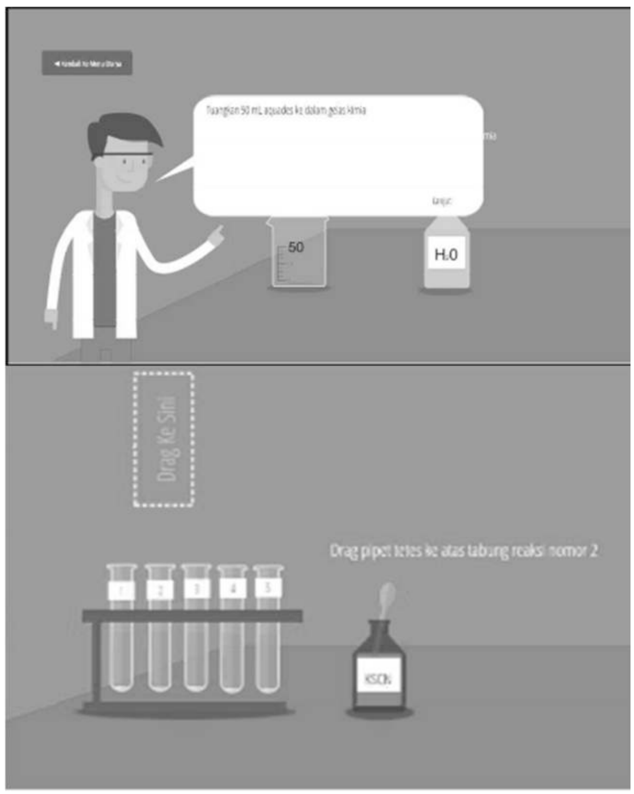

Fig. 1 : Illustration of VICH-Lab integrated with blended online learning

On the opposite side, the chemical equilibrium learning in the control class was performed through the face-to-face learning only without adding online phase learning instruction. Hence, the laboratory work was conducted in the form of a hands-on laboratory. The discussion among the teacher and the students was perceived in the school only, when it was face-to-face or when the teacher had leisure time. The experimental topics of laboratory work simulations in the VICH-Lab were similar to the hands-on laboratory experiment. The detailed research treatment of this research was illustrated in Table 2.

Table 2: Research Treatment

Treatment	Experimental Group	Control Group
Inside Classroom	- Learning theory of chemical equilibrium - Laboratory work using VICH-Lab - Discussion - Presentation	- Learning theory of chemical equilibrium - Laboratory work using hands-on laboratory - Discussion - Presentation
Outside Classroom	- Laboratory work enrichment using VICH-Lab - Online discussion - Reporting the results of laboratory work	- Offline discussion - Reporting the results of laboratory work

D. Data Collection

The non-test and test techniques were used to collect the data in this research. The non-test technique in the form of the Learning Independence Questionnaire was used to manage the data of students' learning independence. At the same time, the test technique in the form of the Chemical Equilibrium Test was used to obtain the data of students' achievement.

1) Learning Independence Questionnaire

The Learning Independence Questionnaire (LIQ) was used to collect and determine students' learning independence levels. A total of 42 items LIQ with four alternative answers scale constructed from various aspects of students' learning independence covering

Table 3 : Sample of Item of Learning Independence Questionnaire

Aspect	Indicator	No of Item	Sample of Item
Attitude	Perseverance in dealing with the task	4	I did the assignment the teacher gave me even though it wasn't collected
	Tenacity in facing difficulties	8	I feel curious if I have not been able to solve the chemistry problems
Motivation	The force to have an achievement	2	I studied chemistry even though there were no tests
	The desire to learn the learning materials deeper	4	I try to find any additional resources in the library or internet to learn chemistry
	Efforts to achieve a better achievement	4	I try my best in dealing with chemistry tests
	The interest about various problems	3	I feel enthusiast when the teacher gives me various chemistry problems
	Happy and diligent in learning chemistry	5	The times flies so fast when I studying chemistry
Self-management	Ability of time management	3	I did not delay in solving chemistry assignment given by the teacher
	Self-evaluation and observation	3	I seek my own leaning style to learn chemistry
Self-confidence	Not depend on others	3	I solve the individual chemistry assignment independently
	Confidence with personal ability	3	I am confidence with my ability in completing the assignment given by the teacher

the attitude (12 items), motivation (18 items), self-management (6 items), and confidence (6 items) was administered through the paper and pencil test. The 42 items of LIQ were distributed in 11 indicators of students' learning independence. The distribution of the item with its example can be seen in Table 3.

The LIQ was first validated before being used to collect the data of students' learning independence. The validation technique was conducted through content validation and empirical validation. A total of 8 experts confirmed the content validation of LIQ. Required revisions were made according to the comments and suggestions from the experts. After the corrections were made, the LIQ was tested towards a group of students, and it was analysed according to Item Response Theory (IRT). The analysis results describe that a total of 42 items were fit to the Rasch Model. Moreover, the reliability of Cronbach Alpha values was found to be 0.86. Therefore, the LIQ was an excellent instrument for collecting the data on students' learning independence.

In addition to LIQ, the students' learning independence data was supported by an Observation Sheet of Learning Independence (OSLI). The observation of students' learning independence was carried out when the face-to-face learning activities was experienced. The aspects of OSLI were the same as those used in LIQ, with the total items to be observed was 11. The OSLI was validated through the content validation towards a total of 9 raters, confirming the OSLI was suitable to measure students' learning independence. Moreover, the OSLI was also validated through empirical validation with three raters. These three raters were observed the learning independence of a group of students. The results of the observations were analysed according to inter-rater reliability, and the Cronbach Alpha value was found to be 0.936. In conclusion, the observation sheet was an excellent instrument to support the data of LIQ.

2) Chemical Equilibrium Test

Chemical Equilibrium Test (CET) was administered after the research treatment had been implemented in order to collect the students' achievement data. The CET consists of 30 multiple choice questions with five alternative answers on the topic of chemical equilibrium. There were five main concepts on the chemical equilibrium topic used in CET, including the dynamic equilibrium, equilibrium constant, equilibrium shift, factors affecting equilibrium, and the application of equilibrium in daily life (see Table 4).

A number of 6 experts approved the CET had an excellent content validation. A necessary revision was

Table 4 : Outline of CET

Basic Competence	Learning Material	Indicator	Level
Describing equilibrium and factors that affect the direction of equilibrium shifting through experiment	Dynamic equilibrium	Describing dynamic equilibrium	C2
		Describing homogeny and heterogeny equilibrium	C2
		Determining equilibrium constant	C3
	Factors that affecting the direction of equilibrium shifting	Predicting the direction of the equilibrium shifting using Le Chatelier law	C4
		Analysing the effects of temperature, pressure, concentration, volume, and catalyst in equilibrium shifting	C5
Determining the quantitative relationship among reactants and product in certain equilibrium reaction	Quantitative relationship among the reactant and product in certain equilibrium reaction	Analysing the experiment data regarding the reactant concentration and product in equilibrium condition to determine dissociation degree and equilibrium constant	C4
		Calculating Kc value based on substance concentration in a equilibrium	C3
		Determining Kp value based on partial gas pressure of reactant and product in equilibrium condition	C3
		Determining Kp value from Kc and vice versa	C3

made according to suggestions and feedbacks from the experts. After that, the CET was administered to 46 students to obtain empirical validation. The data collected from the test were analysed according to IRT with the Rasch model. The analysis yields that all of the CET items fit with the Rasch model. The Cronbach Alpha value of reliability was found to be 0.95. Hence, the CET was an excellent instrument to obtain the data on students' achievement. See one example of CET with the indicator of analysing the effects of temperature, pressure, concentration, volume, and catalyst in equilibrium shifting that presented at Figure 2.

Look at equilibrium reaction below.

$0_6(C) + 1_6(C) \rightleftarrows 201\ (C) \quad \Delta^* = +180$ G,

Based on aforementioned reaction, to make the CO gas that produced are maximum, we need to ....

A. Increasing pressure
B. Decreasing pressure
C. Minimize the volume
D. Increasing temperature
E. Decreasing temperature

E. Data Analysis

The effects of VICH-Lab in blended online learning on students' learning independence and achievement were investigated following one-way Analysis of Variance (one-way ANOVA) technique. The one-way ANOVA analysis was conducted after the prerequisites were fulfilled, covering the data normality and homogeneity test. A descriptive statistic was provided in order to determine the level findings on each dependent variable that has been measured.

3. Findings

The descriptive statistics of students' learning independence and achievement after the research treatment applied in this study were illustrated in Table 5.

Table 5: Descriptive Statistics Data

Group	Parameter	Students' Learning Independence		Students' Achievement
		LIQ	OSLI	
Experimental	N	33	33	33
	Mean	76,14	89,23	80,50
	Std. Dev.	12,40	10,57	8,98
Control	N	32	32	32
	Mean	64,83	71,75	74,30
	Std. Dev.	7,02	18,16	9,34

According to Table 5, overall, the mean score of students' learning independence and achievement toward chemistry in the experimental class was better than those in the control class that implemented hands-on laboratory activities. It can be concluded that the use of VICH-Lab in blended online learning gave significant contribution towards students' learning independence and achievement in chemical equilibrium topics of chemistry lesson.

Moreover, the comparison results of students' learning independence obtained from LIQ and OSLI among the experimental and control class were depicted in Figure 3. We can notice that based on the findings presented on Figure 3, the students' learning independence obtained from the LIQ and OSLI gave the same results. Both data collection tools signified that students' learning independence in the experimental class was better than those in the control class. On the other hand, similar finding was identified on the students' achievement data with the comparison results among experimental and control class presented in Figure 4. According to Figure 4, it was clear that the mean score of students' achievements in the experimental group was better compared to the control group. This leads that the implementation of VICH-Lab in blended online learning has an effect towards students' learning independence and achievement.

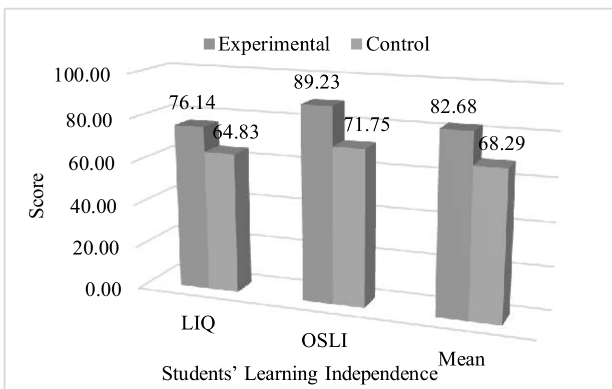

Fig. 3 : Results of Students' Learning Independence

In addition, even though based on Figure 3 and 4, the data of students' learning independence and achievement looked any different, it should be analysed following the statistical methods. The appropriate statistical technique in this context was one-way ANOVA in order to obtain the effects of VICH-Lab on each dependent variable. Since the data of students' learning independence came from LIQ and OSLI, so that both data were combined to establish students' learning independence scores. The mean score obtained will use for the one-way ANOVA analysis. Still, the prerequisite tests covering the normality and homogeneity tests were confirmed to be fulfilled (sig. value > 0.05). The findings of one-way ANOVA analysis that shows the effects of VICH-Lab in blended online learning on students' learning independence and achievement presented in Table 6.

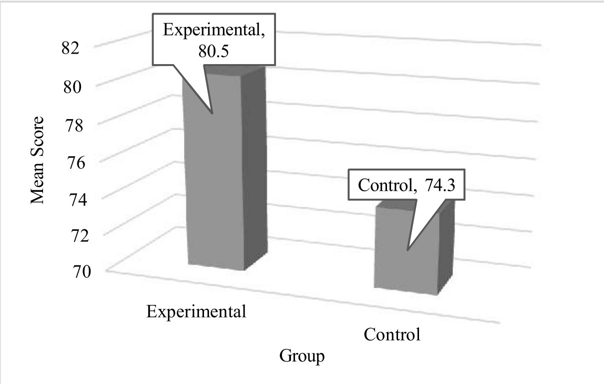

Fig. 4 : Results of Students' Achievement

Table 6: One-Way ANOVA Analysis

Dep Variable	F	P*	Partial Eta Squared
Students' Learning Independence	44.84	0.000	0.42
Students' Achievement	7.45	0.008	0.11

*) Computed using alpha of 0.05

The results of one-way ANOVA analysis in Table 6 describes that there are significant differences in students' learning independence (p-value of 0.000) and achievement (p-value of 0.008) in 95% confidence level among experimental and control group. It also explains that a total of 42.0% and 11.0% of the variance in students' learning independence and achievement respectively. In conclusion, there were significant effects of VICH-Lab in blended online learning on students' learning independence and achievement in chemical equilibrium topics of chemistry lesson.

4. Discussion

IT-based media has an essential role in achieving and improving teaching-learning quality. The IT-based media used in this research was VICH-Lab in blended online learning. The VICH-Lab has been used as an essential tool, supplement, and replacement for real-time laboratory activities (Hawkins & Phelps, 2013). Recent studies showed that the use of a virtual laboratory as a replacement for a hands-on laboratory gives a better result in students' achievement (Špernjak & Šorgo, 2017; Winkelmann et al., 2020), attitude (Winkelmann et al., 2020; Dyrberg, Treusch, & Wiegand, 2016), motivation, and self-efficacy (Dyrberg et al., 2016). This media is appropriate and effective in combining formal and informal learning because it combines with the online phase of blended online learning. Thus, they can use the VICH-Lab anytime inside or outside the classroom, informal or non-formal settings, and incidental in peer groups (Khaddage et al., 2016). The communication between teacher and students was conducted through Moodle (a Learning Management System). Therefore, teachers need to create special topics to initiate the online discussion (Zhaidary et al., 2016). In other words, the students are providing the easiest way to learn any chemistry materials whenever and wherever that cause the enriching their knowledge.

Blended online learning was interpreted as a learning combination between face-to-face and online learning instruction (Nicole & Retta, 2006). As part of technological innovation in mixed learning, blended online learning faces the challenge and has become an influential innovation in teaching-learning instruction (Mugenyi et al., 2016). The VICH-Lab in this research was set in a Moodle to integrate blended online learning. Thus, the students can freely repeat the experimental simulations through Moodle and freely replicate the chemistry learning materials taught by the teacher in the face-to-face learning activities. Several studies prove that the learning materials provided in Moodle lead the students to be well prepared to attend the face-to-face learning instruction, and it brings students' learning independence better.

On the other hand, to improve the students' learning independence by interacting, engaging, and gaining advantages from the learning process, the students should be enrolled in active learning (Carlson, 2016). Learning independence is a learning activity where the purpose of learning is to achieve the learning objectives. Moreover, the regulation of the learning process is decided, guided and managed by students themselves (Balapumi et al., 2014). Since most aspects of our daily lives tend to undergo a profound change; thus, learning independence will allow individuals to respond to the changing demands of work, family and society (Kopzhassarova et al., 2016). The findings of this research revealed that the use of VICH-Lab integrated with blended online learning affects students' learning independence. This is significant because the VICH-Lab media could provide experimental simulations that are closely similar to the actual practical activity in the hands-on laboratory. Thus, the students feel enthusiastic about the presence of the VICH-Lab media in their chemistry learning activities. It enhances students' motivation to learn chemistry learning materials deeper, leading to appearing any topics that should be discussed in the online discussion through Moodle. For this reason, not only increasing the students' learning independence but also the students' achievement also improving confirmed the previous research by Latifah et al. (2018) and Wijayanti et al. (2019).

In this case, the growth of students' learning independence allows them to do everything according to their ability. The students who have higher learning independence will try to pursue solving the exercises or tasks given by teachers with their knowledge; otherwise, those who have lower learning independence depend on others. The VICH-Lab media implementation in experimental class leads the students to be encouraged to do the learning independently because students are required to experience laboratory work activities with VICH-Lab media in the school as a replacement for hands-on laboratory by their selves, and it brings the students' learning independence in this study was improving. While, in the control class that performs the laboratory work through hands-on laboratory, students work in a group due to the limitation of equipment and materials and allocation of time. Some of the students in each group may not have actively participated and depended on their team to finish the experiment that bringing the less students' achievement in the control class were achieved compared to the experimental group. Moreover, Thobroni and Mustofa (2013) state that learning's achievement is an overall behavioural change that produces key results and companions. In the experimental group, since students are performing the laboratory work by themselves, as a key result, it brings meaningful learning and makes the students' achievement well increasing in this group. Moreover, Hawkins and Phelps (2013) suggested that the VICH-Lab was designed with macroscopic representations regarding the colours of the solution so that it leads to the development of students' understanding of chemistry lessons of chemical equilibrium topics. Furthermore, the results of this research are confirmed by previous research experienced by Latifah et al. (2019) and Lopez-Perez et al. (2011) that the VICH-Lab brings a significant improvement in students' achievement.

In addition, Bellindo et al. (2003) confirmed that using an interactive software program of VICH-Lab will obtain better results for students' achievement than those who do not deal with it. The use of VICH-Lab helps students better understand the basic techniques and concepts used in laboratory work. This program primarily contributes to improving students' progress with the most significant learning difficulties. Another study confirmed the results of this study that VICH-Lab can improve learning outcomes (Herga, 2016). This is because the VICH-Lab media with blended online learning makes students easier to access learning materials. Students can increase their learning time by using online access. Moreover, students are well prepared to follow the face-to-face learning process in the classroom (Fitriyana et al., 2021). Therefore, the implementation of VICH-Lab in blended online learning is promising to promote students' learning independence and achievement.

5. Conclusion

The significant effects of VICH-Lab in blended online learning on students' learning independence and achievement in this study were revealed. The VICH-Lab integrated with blended online learning is potential as an alternative way to promote students' learning independence and achievement in chemistry.

Since this research uses the VICH-Lab as a replacement for hands-on laboratory, for future studies, it is suggested to determine the effects of VICH-Lab in blended online learning as a supplement to hands-on laboratory activities. As a supplement, VICH-Lab in blended online learning may give more knowledge and experience to the students because the students can repeat the laboratory work activity at home and explore it more profound as the extension of the laboratory work activities in the natural laboratory. Hence, the effectiveness of VICH-Lab as a potential tool to improve students' pre-laboratory preparation will be revealed.

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