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The Influences of Hybrid Learning with Video Conference and "Chemondro-Game" on Students' Self-Efficacy, Self-Regulated Learning, and Achievement toward Chemistry

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ABSTRACT

The presence of technology is one of prominent characteristics of the 21st century learning system. This study aims to seek the influences of hybrid learning with video conference and chemistry on android game (chemondro-game) on students' self-efficacy, self-regulated learning, and achievement toward chemistry of hydrocarbon topics. Through quasi-experiment with post-test only design, 143 eleventh grade students were selected as the research sample of the study and they were drawn from two secondary schools in Central Java, Indonesia. The sample of the study was composed of three classes based on each group's exposure to different teaching interventions. Experimental Class (EC) received hybrid learning with video conference and chemondro-game, Compared Class-1 (CC-1) was exposed to hybrid learning with video conference only, and Compared Class-2 (CC-2) treated by face-to-face learning with chemondro-game only. The students' self-efficacy, self-regulated learning, and achievement data were obtained using Scale of Self-Efficacy (SSE), Scale of Self-Regulated Learning (SSRL), and the Test on Chemistry Hydrocarbon (TCH), respectively. In addition, an Observation Sheet on Self-Regulated Learning (OSSRL) was prepared to observe students' activities during the learning process. MANOVA technique and descriptive statistics were performed to examine the influences of teaching intervention on students' self-efficacy, self-regulated learning, and achievement in this instructional model. The findings revealed that the teaching intervention has significant influences on students' self-efficacy and self-regulated learning, however no significant influence on students' achievement. Thus, the use of video conference and chemondro-game are strongly suggested in chemistry learning due to its potential to develop self-efficacy and self-regulated learning of the students.

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Introduction

The development of science and ICT (Information and Communication Technology) has rapidly risen. Science and ICT are two important things that are inseparable because nowadays, science and technology are complementing each other in order to produce an innovative learning strategy. As in

chemistry learning, teachers could be designing chemistry learning activities in such a way to yield an innovative chemistry learning by employing ICT. Various studies had implemented technologies in their activities such as innovative web learning (Thohir et al., 2020), laboratory integrated technology (Imaduddin & Hidayah, 2019), blended learning (Wiyarsi et al., 2019), interactive whiteboards (Anatürk-Tombak & Ateşkan, 2019), and android based application for chemistry learning (Ulfa et al., 2017) to improve students' chemical academic performance. Although the use of technologies may be beneficial especially in providing new information and knowledge, it offers disadvantages such hurting concentration of the students and consuming significant amounts of time (Shatri, 2020). Therefore, chemistry teachers play an essential role in managing chemistry learning environment using technology integration. Still, an implementation of technologies is needed to facilitate students in learning chemistry concepts as it could overcome one of the main problems in chemistry learning that it is considered as a difficult subject by students.

According to Sirhan (2007) chemistry curriculum content (sub-microscopic, macroscopic, and symbolic), overloading students' working memory space, language and communication, and motivation to learn chemistry were the main factors causing students' difficulties in learning chemistry. As in hydrocarbon topics of chemistry, the abstract concept of hydrocarbons is caused by the combination of number and letter on chemical structure and the geometry of the structure. Hence, a relevant learning media is required to provide and facilitate students in understanding chemistry of hydrocarbon concepts. The media that is considerable to be used in this era is ICT-based media which provide a new experience for students, as in using chemondro-game that can be found in the play store which served as mobile learning in chemistry. This kind of mobile learning influences students' attitudes, such as providing joy sense in the class and perceiving positive effects on students' learning outcomes (Jabbour, 2014). In addition, many mobile learning applications are available, and these types of mobile learning have various advantages such as providing flexible and portable characteristics (Jeng et al., 2010). Accordingly, mobile learning can facilitate innovative learning processes in the chemistry learning environment in order to achieve desired pedagogical learning strategy. Unfortunately, the mobile learning applications such as chemondro-game are not well implemented in the learning activities since it raises a great skepticism among educators, hence the benefits of these media are scarcely seen (Backlund & Hendrix, 2013).

Another problem found in the aspect of limited allocation of time to learn chemistry in the face-to-face learning in the school, but abundant materials should be delivered to the students. This problem could be overcome by integrating hybrid learning as another way in utilizing ICT in the chemistry learning. The hybrid learning allows the combination of integrating the face to face and online phase of learning activities (Zhao & Breslow, 2013). In this kind of situation, students and teachers need to engage their competencies in using ICT for active learning. The hybrid learning extends students' access and opportunities to learn the knowledge from any location until the face-to-face learning is held (Musawi, 2011). Further, the online activities of hybrid learning could be performed in two types of activities, the synchronous and asynchronous online learning activities (Pandey & Pande, 2014). Video conference is an alternative that can be used in the synchronous online activities of hybrid learning. The video conference enables real time interactions between students and teachers. Therefore, the video conference may help the students to learn chemistry materials by giving additional learning time to enrich their understanding of chemistry. In addition, in the case of asynchronous online learning, a Moodle becomes a choice in perceiving another kind of online learning activities since it offers the exchanging knowledges among the students and the teacher indirectly (Cigdemoglu et al., 2011). The Moodle is beneficial in organizing students' learning materials, collaboration, and data. Therefore, the use of hybrid learning by combining the implementation of chemondro-game, video conference, and moodle give a chance to overcome the problem in chemistry learning as aforementioned. However, the combination of these media is rarely used although it provides many advantages in eliciting students' academic performance.

One aspect of students' academic performance that enhances through an innovative learning strategy using technology is students' self-regulated learning (Kitsantas, 2013). The implementation of

technologies such as hybrid learning with video conference and chemondro-game in the learning activity requires a good self-regulated learner. Students need to regulate themselves to follow and use technologies as their media in learning chemistry into three phases: namely the forethought, performance, and self-reflection phase (Zimmerman, 2008). Thus, the use of technologies such as hybrid learning with video conference and chemondro-game tend to support these three phases of self-regulated learning by helping them in monitoring, integrating, and evaluating learning activities specifically when they are given a task (Mooij, Stefens, & Andrade, 2014). As students become good self-regulated learners, their interest and motivation e.g. self-efficacy develops. Self-efficacy is one of the motivational beliefs based on expectancy-value model (Eggen & Kauchak, 2010). In terms of choice of activities, a higher self-efficacy learner tends to pick in performing the difficult and challenging assignments than the lower one (Kurbanoglu & Akin, 2010). The implementation of hybrid learning with video conference and chemondro-game makes students well prepared to learn chemistry material. They can repeat their chemistry material; thus, they will believe in their capability in understanding chemistry concept that raise students' self-efficacy (Nais et al., 2018). Furthermore, the online activities on hybrid learning allows a higher level of students' self-efficacy (Abdelraheem, 2014). Despite enhancing self-regulated learning and self-efficacy of the learners, the presence of mobile learning media that brings a flexible way of learning chemistry is expected on the improvement of students' achievement. Because high performance of students is associated with their higher level of self-efficacy in subsequent tasks (Wilson & Narayan, 2016). Thus, the implementation of hybrid learning with video conference and chemondro-game is potential to influence students' self-efficacy, self-regulated learning, and achievement toward chemistry since it provides virtual education as an optimal learning environment for students (Rivera, 2016).

Rethinking about aforementioned discussion, the combination of hybrid learning, and chemondro-game may bring a significant influence on the three aspects: covering students' self-efficacy, self-regulated learning, and achievement toward chemistry. Nevertheless, the influences of each ICT-based media on these three aspects also need to be concerned, since the media use in this study has similar characteristics. Hence, the purpose of this study is to seek and compare the influences of different teaching interventions: hybrid learning with video conference and chemondro-game, hybrid learning with video conference only, and face-to-face learning with chemondro-game only on students' self-efficacy, self-regulated learning, and achievement in chemistry of hydrocarbon topics. Thus, this research focused to answer the following research questions.

- Is there any significant influence of teaching intervention on students' self-efficacy among the three groups of instructional models?
- Is there any significant influence of teaching intervention on students' self-regulated learning among the three groups of instructional models?
- Is there any significant influence of teaching intervention on students' achievement among the three groups of instructional models?
- How is the profile of students' self-efficacy among the three groups of instructional models?
- How is the profile of students' self-regulated learning among the three groups of instructional models?

Methods

The Research Design

This research adapted the quasi-experimental with post-test only design. There is an internal threat on the prior condition of the students when employing this design, however the authors had analyzed the condition of the students covering their prior knowledge and characteristics before establishing them as the sample (see research sample and sampling procedures sections). The samples were established into three classes based on different teaching intervention exposed to each group. Experimental Class (EC) receiving hybrid learning with video conference and chemondro-game, Compared Class-1 (CC-1) using hybrid learning with video conference only, and Compared Class-2

(CC-2) treated by face-to-face learning with chemondro-game only. The three different teaching interventions were implemented in order to investigate its influences on the three variables consisting of students' self-efficacy, self-regulated learning, and achievement. Thus, after the teaching intervention had been given, the three variables were measured. The illustration of the research design in this study was presented in Table 1.

Table 1

Illustration of Quasi-Experimental Research Design

Class	The Experimental Manipulations	Post-test
Experimental Class (EC)	Hybrid learning with video conference and chemondro-game	O_1, O_2, O_3
Compared-Class 1 (CC-1)	Hybrid learning with video conference	O_1, O_2, O_3
Compared-Class 2 (CC-2)	Face-to-face learning with chemondro-game	O_1, O_2, O_3

Note. O_1 = Scale of Self-Efficacy; O_2 = Scale of Self-Regulated Learning; and O_3 = Test on Chemistry Hydrocarbons.

Research Sample and Sampling Procedure

All eleventh-grade students majoring in science at the secondary high school at Central Java, Indonesia became the population of this research. The population have similar characteristics such as implementing the recent curriculum of Indonesia, having an excellent accreditation, providing sufficient amenities for implementing ICT-based learning, being 16 to 17 years old, and having accustomed the online phase in their daily activities. In selecting the research sample from the population, the two-stage cluster sampling was performed.

The first stage of cluster random sampling aims to randomly choose two public secondary schools in that Regency. The schools that have been chosen have thirteen eleventh grade classes majoring in science. Thus, the second stage of cluster random sampling aimed to assign the three classes that would be used in this research. Prior to establishing the classes as the research samples, the difference of achievement and the class characteristics of the thirteen classes that exist in that school were initially analyzed. The achievement was analyzed through their summative test data by performing one-way analysis of variance (one-way ANOVA). The finding on this analysis showed that no significant difference was found on students' prior knowledge in chemistry among the available classes (p-value 0.414 > 0.05). While the students' characteristics on all classes were analyzed through observation and interview with the existing chemistry teachers. The observation and interviews were performed in the informal way. The researchers attended and observed all classes that would potentially form the research sample. We observe the characteristics of each class when the chemistry learning was held. Moreover, an informal interview was conducted by discussing the performance of each class with the chemistry teachers. According to the result of observation and interview activities, it was found that generally all classes had the same characteristics in the term of enthusiasm in following chemistry lesson. Therefore, all of the class had the same opportunity to become the research sample of this study. Thus, the authors randomly picked three classes and randomly assigned into EC consisting 48 students, CC-1 comprising 45 students, and CC-2 of 50 students. The total number of the research sample was 143 students.

Phrased differently, as ethical consideration, the research activities conducted after a legal permission had been accepted by selected secondary high schools in this research. Further, the research sample declared that they voluntarily agreed to become the research sample of this study. Therefore, this research was confirmed to be conducted without forcing the research sample.

Instruction Process

There were three groups that were taught by different experimental manipulation in this research. Therefore, to reduce the internal threat validity, the chemistry teaching practice was run by

the same teacher. Since the teaching intervention used hybrid learning, there were two phases of learning activities held, the face-to-face and online learning phase. Thus, the learning activities held in EC and CC-1 were in the form of face-to-face and online learning activities. The online learning phase in these two classes became the supplement of face-to-face learning in order to enrich students' knowledge. The online learning performed through synchronous using video conference and asynchronous using Moodle. However, in the EC, chemondro-game was added instead of hybrid learning. On the other hand, in the CC-2, the learning activities only held in the form of face-to-face learning treated by giving chemondro-game. The face-to-face learning in these three classes is devoted to constructivism learning theory that is the 5E learning cycle model covering the engagement, exploration, explanation, elaboration, and evaluation syntax. Therefore, all the research sample perceived active learning that leads on meaningful learning because they construct their own knowledge in hydrocarbon topics. All the students also work collaboratively with their peers in a small group in constructing their knowledge. See the example of experimental manipulations among the three classes of this research that is illustrated in Table 2.

Research Instruments

Through single measurement that is after the experimental manipulation has been implemented, the students' self-efficacy, self-regulated learning, and achievement data were collected. The Scale of Self-Efficacy (SSE), Scale of Self-Regulated Learning (SSRL), and Test on Chemistry Hydrocarbon (TCH) were employed to obtain the data of students' self-efficacy, self-regulated learning, and achievement toward chemistry, respectively. The SSE, SSRL, and TCH were prepared by the researchers.

The Scale of Self-Efficacy (SSE)

The Scale of Self-Efficacy (SSE) used to obtain the data of students' self-efficacy. This SSE comprises a total of 23 points of items with 4 Likert-type scales i.e., very confident, confident, not confident, and extremely not confident. The characteristics of the students having higher and lower self-efficacy were used as the basis in constructing the SSE. These characteristics that were used as a basis were following self-efficacy concepts from Bandura, (1994); Zimmerman., (2000); Eggen and Kauchack, (2010); Santrock, (2011); and Uzuntiryaki, (2008). The SSE was confirmed to be valid by its content and empirically. The content validity declared to be valid by experts in the field of chemistry education and psychology. While the empirical validity examined by a large group of students that have the same characteristics with the sample. A pilot study was carried out to determine the Cronbach Alpha value of the SSE and was found to be 0.72, which indicated the SSE was a reliable tool to obtain students' self-efficacy data.

Scale of Self-Regulated Learning (SSRL)

A total of 15 items on the Scale of Self-Regulated Learning (SSRL) was used to collect the data of students' self-regulated learning. Like the SSE, the SSRL was constructed following Likert type scale of 4 points assessment varying from extremely agree to extremely disagree. In constructing the SSRL, it used the basic phase of self-regulated learner from Effeney et al. (2013); Vrieling et al. (2012), Kitsantas, (2013), Virtanen et al. (2013), and Zimmerman, (2008) such as the planning, implementation, and evaluation phase. Similarly with SSE, the validation of SSRL conducted through the content and followed by empirical. SSRL confirmed to be valid by it's content by the experts from chemistry education and psychology fields. After that, the pilot study was performed to determine the empirical validation of the SSRL.

Table 2

Experimental Manipulations of the Research

Teaching Intervention	Research Sample		
	EC	CC-1	CC-2
Face-to-face learning	The lesson began by declaring that every compound has chemical and physical characteristics. Then they ask how the relationship is among the structure of hydrocarbon compounds with its boiling point and the possibility of the compound having a similar molecular structure.		
	Engagement The students observe a table showing the relationship among boiling point and molecular mass of hydrocarbon compounds also the structure of hydrocarbon and molecular mass of the compound. They were questioning that is it possible if the same molecular compound has several various molecular structures?		
	Exploration The students work with their peers in a small group to explore any resources and discuss about physical properties and isomerism of hydrocarbon e.g., structure isomerism, position isomerism, and geometry isomerism to construct their own knowledge		
	Explanation The teacher gave the students an opportunity to present their knowledge they got from the exploration phase. Another group of students are allowed to respond and gave feedback about their classmate presentation. The teacher gave feedbacks about the presentation of the students.		
	Elaboration • The students elaborate their knowledge by correlating the structure of hydrocarbons of alkane, alkene, and alkyne with its physical properties based on the number of C atoms toward its boiling point. • Students elaborate their understanding by reading the materials from chemondro-game	Elaboration • The students extend their understanding by trying to find a relationship among the structure of hydrocarbons of alkane, alkene, and alkyne with its physical properties based on the number of C atoms toward its boiling point. • Students elaborate their understanding by reading any resources	Elaboration • The students elaborate their knowledge by correlating the structure of hydrocarbons of alkane, alkene, and alkyne with its physical properties based on the number of C atoms toward its boiling point. • Students elaborate their understanding by reading the materials from chemondro-game
	Evaluation • Students evaluate their understanding by playing chemondro-game and solving all the problems provided in the game • Students are given a task to make a certain model of hydrocarbon isomerism	Evaluation • Students evaluate their understanding by solving exercise given by teacher • Students are given a task to make a certain model of hydrocarbon isomerism	Evaluation • Students evaluate their understanding by playing chemondro-game and solving all the problems provided in the game • Students are given a task to make a certain model of hydrocarbon isomerism
Online learning	Asynchronous Students discuss the assignment with their peers through Moodle. The teacher set a due time for the task submission.	Asynchronous Students discuss the assignment with their peers through Moodle. The teacher set a due time for the task submission.	- (Because no online phase was held in this group, the students submit the task directly to the teacher. The discussion of the task given to them held in the face-to-face phase when they are having spare time)
	Synchronous The students present their hydrocarbon isomerism model through video conference. They were given direct feedback from the teacher and their peers.	Synchronous The students present their hydrocarbon isomerism model through video conference. They were given direct feedback from the teacher and their peers.	

Through this activity, the estimation of Cronbach Alpha value of SSRL was found to be 0.72. Therefore, the SSRL was found to be a reliable instrument to obtain the data of students' self-regulated learning.

In addition, an Observation Sheet on Self-Regulated Learning (OSSRL) was prepared to determine the activities of students during the learning process. The observations were made for three times on each class during the teaching intervention. The aspect of self-regulated learning between the SSRL and OSSRL was the same, that covers the planning, implementation, and evaluation phases. Thus, the data of OSSRL was valuable to support the results on SSRL in this instructional model. A total of three observers were enrolled in assessing students' activities. Therefore, in order to reduce the subjectivity of these three observers, the OSSRL was completed by scoring rubrics varying score from 4 (excellent) until 1 (very poor). See Table 3 for the example of the scoring rubrics on implementation phase of OSSRL. In addition, the OSSRL was validated by face and content validity by a group of experts.

Table 3

Example of OSSRL Scoring Rubrics

Self-regulated learning phase	Observation Indicator	Criteria			
		Excellent	Good	Poor	Very Poor
Implementation	Focusing attention on hydrocarbon chemistry learning activities	The student was always paying attention to the learning activities, response the teacher feedbacks, and actively participated in the discussion.	The student was always paying attention to the learning activities, response the teacher feedbacks however they do not actively participate in the discussion.	The student was paying attention to the learning activities however they do not response the teacher feedbacks and do not actively participate in the discussion.	The student was not paying attention to the learning activities, response the teacher feedbacks, and actively participated in the discussion.

Test on Chemistry Hydrocarbon (TCH)

Students' achievement data collected through the Test on Chemistry Hydrocarbon (TCH). The TCH covers a total of 29 questions consisting of 4 open ended and 25 multiple choice questions. The multiple-choice questions consist of five alternative answers. The TCH was distributed according to the basic competences which students must master on hydrocarbons topic, the main concept of hydrocarbon, and cognitive level of revised Bloom Taxonomy (Krathwohl, 2002). The main concept of hydrocarbons that use in the TCH covering the properties of carbon atoms and its classification; nomenclature of alkane, alkene, and alkynes; physical properties and isomerism of hydrocarbons; also, reaction of hydrocarbons. Like SSE and SSRL, the TCH also validates through the content and empirical way. The experts from the field of chemistry and chemistry education reported the content of TCH was valid. Furthermore, a pilot study toward a group of students outside the research sample was used to confirm the empirical validity. Through this pilot study, the Cronbach Alpha value of TCH was found to be 0.93. Accordingly, the TCH belongs to a highly reliable tool to obtain students' chemistry achievement data on hydrocarbons topic.

Data Analysis

Multivariate Analysis of Variance (MANOVA) was performed to examine the influences of teaching intervention on students' self-efficacy, self-regulated learning, and achievement in this instructional model. There three test assumptions of MANOVA have been made before the MANOVA

was performed (Stevens, 2002; Hair et al., 1998). Through MANOVA, the research questions that seek the influences of the treatment on each dependent variable can be observed from the finding on the test of between subject effects. In addition, descriptive statistics was executed and followed by providing a chart in order to compare the mean score of the profile of students' self-efficacy from SES and self-regulated learning from SSRL and OSSRL among the three classes.

Findings

The findings section provides the results of the research on the three dependent variables. The descriptive statistics presenting the mean score, standard deviation (*SD*), number of students, the highest, and the lowest score on each dependent variable illustrated in the Table 4.

Table 4

The Descriptive Statistics on Students' Self Efficacy, Self-Regulated Learning, and Achievement

Class	Dependent variables	Data Source	N	Mean	*SD*	Highest Score	Lowest Score
EC	Self-efficacy	SSE	48	67.94	9.70	70.54	65.34
CC-1			45	64.47	7.94	67.15	61.78
CC-2			50	60.84	9.48	63.39	58.30
EC	Self-regulated learning	SSRL	48	38.50	7.97	40.61	36.39
CC-1			45	36.64	7.41	38.83	34.47
CC-2			50	41.32	6.78	43.39	39.25
EC		OSSRL	48	33.09	6.97	56.00	19.61
CC-1			45	35.50	7.08	48.65	21.17
CC-2			50	38.59	5.35	49.92	24.16
EC	Achievement	TCH	48	71.19	13.84	75.06	67.32
CC-1			45	76.60	11.90	80.60	72.60
CC-2			50	73.24	14.65	77.03	69.45

As seen in Table 4, the EC signified highest mean score of self-efficacies, the CC-2 indicated highest score of students' self-regulated learning, and CC-1 attained highest students' achievement. Moreover, on the finding on students' self-regulated learning, the result from SSRL supported by the OSSRL that CC-2 had the highest score of students' activities in the term of students' self-regulated learning during the chemistry of hydrocarbon learning.

The Influences of Teaching Intervention on Students' Self-Efficacy, Self-Regulated Learning, and Achievement

The result of multivariate test in order to observe the significant influences of the three teaching interventions is illustrated in Table 5.

Table 5

The Results of Multivariate Test

Multivariate Test	Value	F	P-value	Conclusion*)	Partial Eta Squared
Roy's Largest Root	0.42	19.57[c]	0.00	Significantly different	0.30

Note. *) Computed using alpha = 0.05

Exploring the result of multivariate test on Table 5, it presents that at the 95% confidence level found a significant influence of the instructional models on the three dependent variables ($p = 0.00 < 0.05$). It also revealed that the teaching interventions describe 30% of the variance of overall dependent

variables. The significant influences toward these three variables due to the different instructional models applied to each class. On the other hand, in order to seek the influences of the experimental manipulations on each dependent variable, the result of the test between subject effects as another output of MANOVA analysis is presented in Table 6.

Table 6

The Individual Comparison among Students' Self Efficacy, Self-Regulated Learning, and Achievement

Dependent Variables	Type III SS	df	MS	F	P-value	Conclusion*)	Partial Eta Squared
Self-efficacy	1234.36	2	617.18	7.45	0.00	Significantly different	0.10
Self-regulated learning	529.44	2	264.72	4.84	0.01	Significantly different	0.06
Achievement	690.837	2	345.42	1.88	0.16	No different	0.03

Note. *) Computed using alpha = 0.05

Examining the result of individual comparison among the dependent variables in Table 6, it shows that the instructional models bring a significant influence on students' self-efficacy and self-regulated learning. However, no significant influence on students' achievement was found. The experimental manipulations explain a total of 10%; 6%; and 3% of the variance on students' self-efficacy, self-regulated learning, and achievement, respectively. Furthermore, the output of Post Hoc test aims to find out which teaching intervention is giving stronger influence. The results of the Post Hoc test on students' self-efficacy showed that the significant difference found among EC and CC-2 in favour of EC. Therefore, the EC provides the strongest influences on students' self-efficacy. As a contrast on students' self-efficacy, the results of the Post Hoc test on students' self-regulated learning signified that there were significant differences among CC1 and CC-2 in favour of CC-2. Thus, the CC-2 giving the strongest influences on students' self-regulated learning on the chemistry of hydrocarbon topics.

The Profile of Students' Self Efficacy and Self-Regulated Learning

The profile of students' self-efficacy and self-regulated learning in this research were presented in Figure 1 and Figure 2.

Figure 1

Self-Efficacy Profile

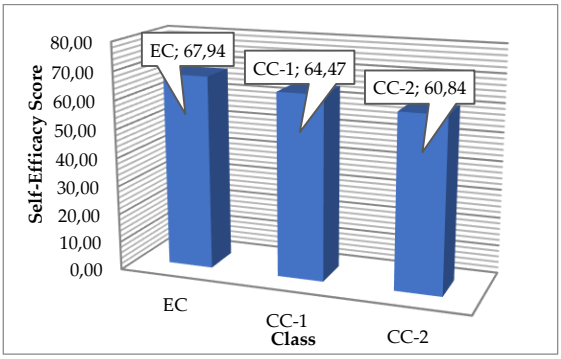
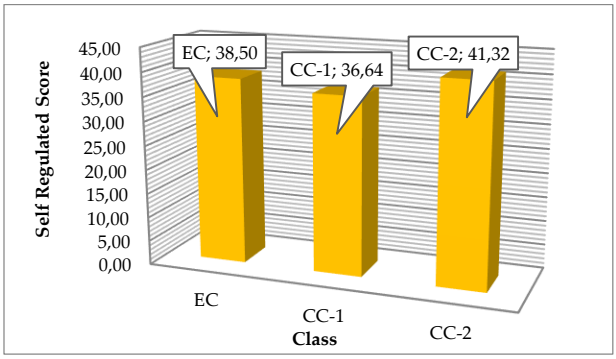


Figure 2

Self-Regulated Learning Profile

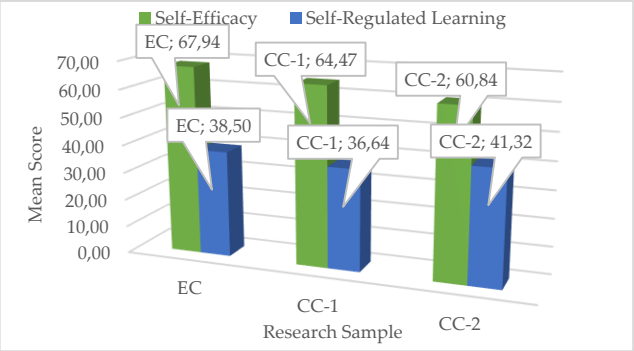


Based on Figure 1 and 2, it seems that in the EC and CC-1, students' self-efficacy determined the results of their self-regulated learning. However, for CC-2, although the students' self-efficacy was the lowest, self-regulated learning was the highest among the remaining classes. Moreover, the comparison

of the profile of students' self-efficacy and their self-regulated learning on each class of this research was illustrated in Figure 3.

Figure 3

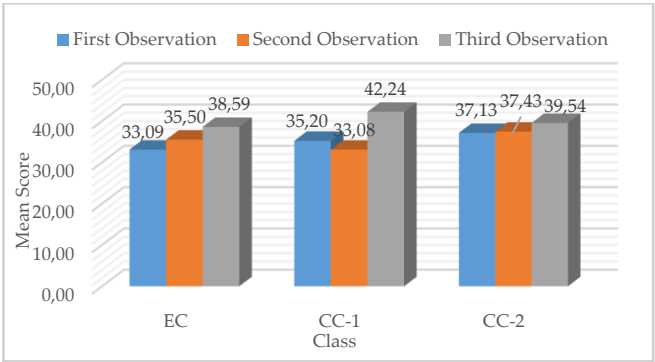
The Comparison of Students' Self-Efficacy and Self-Regulated Learning



Interestingly the findings on Figure 3 depicts that in the CC-2, a well self-regulated learning implied a lower students' self-efficacy. Furthermore, the findings on OSSRL were confirmed the results on students' self-regulated learning. The profile of self-regulated learning of the learners based on OSSRL during the chemistry learning activities illustrated in Figure 4.

Figure 4

The Findings of OSSRL on Students' Self-Regulated Learning Profile



The findings on Figure 4 shows that students' self-regulated learning tends to increase during the teaching intervention for overall the three classes used in this research.

Discussion

The discussion concerning what the results of this research describes is in this section. The teaching intervention employed in this research is embedded with technology-based media, thus it belongs to an effort to build innovative learning strategies in dealing with 21st century learning. The results of this research indicated that the different teaching interventions have different influences on the three dependent variables.

The Influences of Teaching Intervention on Students' Self-Efficacy, Self-Regulated Learning, and Achievement

Different treatment on EC, CC-1, and CC-2 gives significant influence on students' self-efficacy and self-regulated learning, however it does not bring significant influence on students' achievement. As observed in the Table 4, in the term of students' self-efficacy it is revealed that the EC that employs hybrid learning with video conference and chemondro-game has the strongest influence, while in the term of students' self-regulated learning the CC-2 that integrates face-to-face learning mediated with chemondro-game offers the strongest.

When varied studies examined the fundamental concepts on students' self-efficacy, there is no doubt that higher self-efficacy learners tend to pick a challenging assignment, release a high effort to solve the assignment, and easily control their anxiety on failure compared to those with the lower efficacy (Eggen & Kauchak, 2010; Bandura, 1994; Kurbanoglu & Akin, 2010). Alqurashi (2016) and Prifti (2020) reported that self-efficacy on students that enroll in an online learning environment signified a positive effects toward students' performance in hybrid learning. Further, the role of hybrid learning is potential in constructing students' belief regarding their competencies in building knowledge (Tanti, et al., 2018). Through hybrid learning, it gives an opportunity to the students to freely in accessing the chemistry learning materials. While, the presence of mobile learning technology such as chemondro-game also provides a chance to develop students' self-efficacy (Hung, Huang, & Hwang, 2014) because it contains learning materials that could be utilized in a flexible way. The hybrid learning with video conference and chemondro-game will have an effect on students' confidence regarding their capability in mastering chemistry concept. Therefore, the results of this research confirmed aforementioned previous studies. The hybrid learning mode with an enrichment using chemondro-game sharpening students' belief in their performance on hydrocarbon lesson thus their self-efficacy improving. This self-efficacy related to their self-regulated learning.

Self-efficacy is defined as motivational beliefs that develops and maintains the self-regulated learning of the learners while the motivational strategies in the learning activities in order to achieve desired goals was correlated to students' self-regulated learning (Zimmerman, 2008). The CC-2 that employs face-to-face learning with chemondro-game has the strongest influence on students' self-regulated learning. The chemondro-game in this research consists of learning outcomes, learning materials, and evaluation that employs game rules. Further, the chemondro-game belongs to an educational game that is found in the android mobile and accessible to the students, hence it promotes students' to learn independently and has an influence on increasing of students' self-regulated learning (Wiyarsi et al., 2019). The result of this research is confirmed by Jabbour (2014) as mobile game technology has a positive effect on the interactions between students and their peers and their teacher thus it signified on the enhancement of students' learning outcomes. Well interactions that are experienced by students leads to strengthening of their regulated learning. Similar findings was also found by Yildiz et al. (2018) as educational games make students actively participate in the learning activities, thus they are enthusiastic in following the chemistry lesson. The higher enthusiasm of students in following the learning activities contributes in maintaining their willingness to learn chemistry, accordingly it improves students' self-regulated learning in chemistry.

On the other hand, students who manage their self-regulation strategies i.e., planning study, monitoring learning progress, adjusting behaviour towards learning environment will signify a good academic adjustment because it is a path to students' academic achievement (Cazan, 2012). Therefore, students' self-regulated learning has a great influence on the students' academic performance (Peng, 2012). The CC-1 that integrates hybrid learning mediated with video conference offers the strongest influence on students' achievement. The presence of video conferences in synchronous online learning provides learning activities almost the same with the face-to-face learning because it allows direct interactions in real time. The increasing interaction in the hybrid learning process correlated with students' enhancement of achievement (Coll & Coll, 2017). As a distant learning technology, the use of video conference offers various benefits e.g., expanding learning access, providing flexible lesson

schedule, cost-effective, etc. (Pandey & Pande, 2014). Additionally, a Moodle used in the asynchronous online learning serves the students to manage and access learning materials anytime and anywhere. Alonso-Mecia et al. (2019) reported that the use of Moodle offers the students to engage in their interest, motivation, and previous knowledge that signified on students' academic achievements. Furthermore, Suana et al. (2017) reported that hybrid learning is an effective way to promote students' conceptual understanding. Another study experienced by Jahjouh (2014) illustrates that the online activities of hybrid learning increases students' achievement, skill, and attitude. The presence of hybrid learning is significant towards achievement of the learners since it offers as an independent learning source (Fitriyana et al., 2018). Unfortunately, the combination of video conference and Moodle that was implemented in the online activities of this research did not brings significant influences on students' achievement. Because the teaching interventions bring similar advantages such as perceiving the chemistry of hydrocarbon lessons in a flexible way, it makes a similar influence on students' achievement. It is proven when the mean score of students' achievements on the three groups of students that is relatively high (see Table 4).

The Profile of Students' Self Efficacy and Students' Self-Regulated Learning

Students' self-efficacy has an important role on students' self-regulated learning. Learning activities involving more self-regulation requires the role of self-efficacy as it correlates with managing students' learning strategies (Zimmerman, 2008). Kitsantas (2013) explains that students with a high self-regulated learning will point to higher self-efficacy and outcome expectations than those with lower self-regulation. The results of Temel (2013), Tavakolizadeh and Qavam (2011), Abdullah (2016), and Wilson and Narayan (2016) show a strong correlation among students' self-efficacy and students' self-regulated learning. Unfortunately, the results of this research are in conflict with aforementioned studies (see Figure 1 and Figure 2). Especially on CC-2 that students' self-efficacy does not determine their ability to regulate themselves in learning the chemistry of hydrocarbons. Thus, it supports the findings of Puzziferro (2008) that proposed the self-efficacy of online user's technology was not linked with their performance such as self-regulated learning.

As seen in Figure 2, despite the students' self-efficacy in CC-2 signified the lowest mean score, its self-regulated learning was the highest. The CC-2 employed chemondro-game that helps students to learn independently. Puspita et al. (2017) reported that the use of the mobile based application contributes to the improvement of students' cognitive achievement. It offers an independent and flexible learning source than another learning media. The students are motivated and interested in using chemondro-game, but they have a lack of belief in utilizing the chemondro-game as the learning media that made the result of the study. Another fact that is revealed was the mean score of students' self-efficacy that has been good, thus it was not really sensitive in predicting their self-regulated learning. It may be caused by an element of students' self-regulated learning that did not achieved e.g., in the phase of self-reflection. Mostly students found difficulties in drawing self-reflection based on their learning outcomes.

Phrased differently, the data on the profile self-regulated learning of the students that was strengthened by OSSRL. According to the results of OSSRL, the self-regulated learning of the students tended to increase gradually. An enhancement of students' self-regulated learning perceived through a process form an online learning phase. Students are assigned with different types of tasks in this online activity. It brings the students to be familiar to the assignment given by teachers, thus it leads their regulation higher. Learning activities are a lifelong process that requires a good self-regulated learner (Wilson & Narayan, 2016). Therefore, students who initiate to increase their knowledge and their skills are well prepared for dealing with the dynamic world.

Conclusion and Implications

This study provides an overview on how to overcome several problems in chemistry learning e.g., considered difficult by the students and limited time allocation with abundant materials should be mastered by the students. Thus, the current study employs hybrid learning with video conference and chemondro-game as an alternative chemistry learning strategy. The findings revealed that the teaching intervention has significant influences on students' self-efficacy and self-regulated learning, however it does not have significant influence on students' achievement. Additionally, the findings also revealed that the combination of hybrid learning with video conference and chemondro-game implied the strongest influence on students' self-efficacy. While, the use of chemondro-game only signified the strongest influence on students' self-regulated learning. Therefore, the use of these media was strongly suggested in chemistry learning because of its potential to develop self-efficacy and self-regulated learning of the students. Phrased differently, self-efficacy was not found to be a significant contributor to predict students' self-regulated learning. It is due to the mean score of students' self-efficacy that has been good, thus it was not very sensitive in predicting their self-regulated learning.

Considering the results of this research, it is suggested to vary the research samples in the term of students grades and topics. Therefore, the effectiveness of hybrid learning with video conferences and chemondro-game will be strengthened. Enabling flipped classroom model is also offered as another alternative in conducting hybrid learning (Shih, Liang, & Tsai, 2019). Moreover, an individualized learning behaviour in hybrid learning should be considered since it offers an effective way to improve students' learning performance (Zhang, et al., 2019). Finally, a longitudinal study concerning the implementation of this kind of learning strategy could be conducted in order to seek the perception among the teacher and students in perceiving the teaching intervention.

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