



Implementation of Phenomenon-based Learning E-Module to Improve Critical Thinking Skills in Thermochemistry Material

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Abstract. The covid-19 pandemic in Indonesia has affected various sectors, one of them is in the education sector. Thus, it interferes with the learning processes conventionally. A solution is needed to respond to the problem in the 21st century. Online learning is one of the alternative ways in utilizing the use of IT-based teaching materials. This study aims to improve the students' critical thinking skills by using an e-module. The research was the quantitative descriptive method. This study was a quasi-experimental by using a nonequivalent control group design. The samples of the study consisted of 2 classes, namely XI MIPA 1 and XI MIPA 2. The analysis results using independent sample t-test showed a significance value of $0,000 < 0,05$. The data analysis results of critical thinking skills used N-gain score test; the experimental class obtained a score of 0,72, in which it belonged to the high category. Meanwhile, the average N-gain score for the control class was 0,34, in which it belonged to the medium category. It can be concluded that there is a significant difference in the students' critical thinking skills between the experimental class and the control class. Therefore, the implementation of a phenomenon-based learning e-module can be an alternative to improve the students' critical thinking skills.

Keywords: E-Module, Phenomenon-based Learning, Critical Thinking Skills, Thermochemistry

Introduction

In 2020, the world is shocked by a new outbreak, namely the coronavirus (Covid-19) which every day infects almost all countries in the world. Covid-19 first appeared in Wuhan, Hubei Province at the end of 2019. The impact of the Covid-19 pandemic provides a very large influence in various sectors of life, one of them is in the education sector. Data obtained from World Education Agency (UNESCO) reveal that more than 69 countries in Asia, Africa, Europe, Australia, and America limit face-to-face learning in schools and universities, learning is also implemented online (United Nation of Educational, 2020). The impacts of the Covid-19 Pandemic have changed the order of life in various aspects, including education.

This virus is known to be transmitted and spread very easily from one human to another. One of the efforts to prevent the spread of this virus is the closure of educational institutions (Putria, et al., 2020). The closure of educational institutions requires teachers and students to switch to virtual learning systems or what can be called online learning (Gurukkal, 2020). Enforcement of online learning or distance learning can ease the students to keep participating in the learning processes and it is also considered safe to avoid

the spread of the coronavirus for the teachers and the students who affected by the Covid-19 pandemic (Milman, 2015; Alchamdani, et al., 2020).

The online learning model integrates formal and informal learnings, it stimulates collaboration with colleagues and specials and creates virtual communities. In this case, it will further spur the professional competence of teachers in planning, implementing, guiding/managing, assessing the progress of the teaching and learning process (*PBM*) during this pandemic (Zulkifli & Royes, 2018). In the online learning processes, it requires planning to integrate the development of information and communication technology (ICT) (Huang & Hew, 2016; Dewi & Primayana, 2019). This is also a demand in the 21st-century learning process and requires the teachers and the students to be more literate in utilizing the technologies.

The advantage in implementing this learning process is that the students can control their learning schedule with the learning speed they want (Elfrianto, et al., 2020). Thus, it can provide opportunities for students who previously had limited costs, distance, and time to reach it. However, there are several obstacles i.e. inadequate internet access that can affect the implementation of learning (George, 2020). There are still many students who cannot take part in the online learning process because of the unstable internet; thus, it requires the students to find out a location for fast and stable internet access during the learning process (Alchamdani et al., 2020).

According to Piaget's theory, High School students are children who are in the 11-15 years age range classified in the formal operational stage which is characterized by the ability to think abstractly, reason logically, and draw available conclusions (Ibda, 2015). Therefore, it requires something new to attract their attention in receiving the learning. One of them is that the teachers can use ICT-based teaching materials as a learning resource for students during the Covid-19 pandemic.

There are a lot of learning media that are technology, one of which is an electronic module or e-module. E-module is one of the teaching materials that can be accessed thru various gadgets i.e. smartphones, tablets, and laptops as well. The use of teaching materials in the form of e-module has characteristics such as self-instructional, self-contained, stand-alone, adaptive, and user friendly, the use of font, space, and consistent layout, is delivered thru computer-based electronic media, and it utilizes various choices of software application and it is designed using teaching and learning principles (Kemendikbud, 2017). Hence, it can support the learning processes to be better.

Chemistry is a branch of science that studies the composition, structure of a substance, changes in the composition or properties of substances, and changes in energy that occur. In chemistry, it is also studied about natural phenomena. Based on these natural phenomena, concepts, theories, laws, and facts are compiled. Chemistry demands the presentation of facts not only based on legible concepts. These facts will be better understood as a product of the results of thinking if it is implanted directly in the learning process of students. Thus, in addition to being able to obtain knowledge in the form of material, the students also acquire skills to construct new knowledge (Susparini & Ashadi, 2016). Consequently, the teachers should be able to connect the learning material that is being studied with the existing phenomena so that the students can discover the real meaning of the material that has been studied.

The students are stated to understand the chemistry learning if the students have met the graduate competency standard, of which standard had been regulated in Regulation of the Minister of Education and Culture. In accordance with predetermined standards, the students have to comprehend the chemistry concepts and implement the concepts in daily life. To reach the learning objectives, it requires interesting teaching materials based on phenomena so that the students can emphasize the discovery of the concept like the experts who find out chemical concepts in their era (Akhir, et al., 2015). The phenomenon-

based e-module is based on constructivist learning theory. Through the observed phenomena, the students build knowledge in their minds; then, they connect it with initial knowledge so that they acquire a complete concept (Lawson, 2004). Thus, the students can hone their skills and abilities to think.

The implementation of curriculum 2013 also plays an important role in the learning processes. The curriculum 2013 directs the students to think critically and be active in the learning (Dewi, et al., 2019). Critical thinking skill is based on the activities to connect and draw a conclusion of an idea and event which implicates various cognitive processes i.e. problem-solving, phenomena explanation, problem identification, examining, reflecting, and criticizing (Sendag & Odabasi, 2009). Therefore, critical thinking skill is one of the thinking skills needed in phenomenon-based learning that can be implemented through electronic-based teaching materials in the form of e-modules.

The teachers' roles are needed in constructing the students' critical thinking skill, the teachers are required to make changes on the learning processes in class, in which it directs the students to practice their critical thinking skill. One other effort is by using a phenomenon-based e-module. The advantage of a phenomenon-based e-module compared to other e-modules is that there are 5 important aspects in its activities, namely observing phenomena, compiling provisional explanations, investing/investigating, compiling final explanations, and providing reasons (Islakhiyah, et al., 2018).

The ability to think critically of Indonesian students is lower because it has not referred to the competencies tested in PISA; thus, the students do not understand the concepts and it results in low critical thinking skills. Chemistry learning does not only need to emphasize the cognitive realm but also construct critical thinking skills (Maulana, et al., 2015). According to the observation and interview at SMAN 2 Tapung Hulu, SMAN 3 Tapung, and SMAN 5 Tapung Kampar Regency, the information obtained is that in the chemistry learning process, specifically in thermochemistry, the students are less interested to learn due to the material that has a lot of arithmetic material. Moreover, based on the results of initial testing using critical questions, many students cannot answer because of the lack of students' ability to answer questions that require simple explanations. To solve the problem, media are needed such as animation video thru an e-module that can explain the concepts of the sub-material. Therefore, this study is important to be carried out which aims to improve the students' critical thinking skills thru a phenomenon-based e-module.

Based on the results of study conducted by (Latifah, et al., 2020) at University of Muhammadiyah Purworejo, Central Java, it indicates that the implementation of e-modules can improve the students' critical thinking skills. The results of the study reveal the improvement in learning outcomes by means of e-modules compared to conventional learning with printed books. The scores obtained during the pretest are the average scores of 33,19 and the posttest scores are 73,47, in which it obtains the gain criteria of 0,602 with a medium category since the gain value is included in the normalized gain criteria of $0,3 \geq g \geq 0,7$ (Latifah, et al., 2020). The difference between previous studies with this study is on the use of phenomenon-based e-module.

The phenomenon-based e-module is implemented in the experimental class, while the controls class uses regular textbooks. This study aims to improve the students' critical thinking skill using a phenomenon-based e-module in XI MIPA 3 class of SMAN 3 Tapung. Hypothesis of this study is that there is a difference on the students' critical thinking skill before and after using the phenomenon-based e-module. The significance of this study is to be able to improve the students' critical thinking skills using a phenomenon-based e-module.

Methods

The method of study that carried out was quantitative method. This study was a Quasi-Experimental study using non-equivalent control group design. This study was conducted on November 2020. The location of this study was in SMA Negeri 3 Tapung, Kampar. The samples of this study were obtained thru a *purposive sampling* technique. The sample selection was based on the need of study by means of teachers' recommendation to the learning skills and the domination of students who had smartphones and laptops. The learning activities were carried out online by using ZOOM application, WhatsApp, and Google Classroom as well. There were 30 students used as the samples of this study, of which students were the students of XI MIPA 1 and XI MIPA 2 at SMA Negeri 3 Tapung in the academic year of 2020/2021.

Interview and critical thinking skill test were used as the techniques of the data collection in this study. Data analysis techniques for normality test used *Shapiro Wilk* test and statistical analysis was done by examining the hypotheses using the *independent sample t-test*, in which it was assisted by SPSS 25 program and the withdrawal of the conclusion was in the significance level of 5%. If the significance level was $> 0,05$, the H_0 was rejected and the H_a was received. From the t-test results, there would be differences in the students' critical thinking skills before and after using the e-module. Furthermore, it would be analyzed to categorize the type of increase using the N-Gain test with the categories in Table 1 (Hake, 1999).

Table 1. Criteria of N-Gain

N-Gain Score	Interpretation
$(\langle g \rangle) > 0,7$	High
$0,3 < (\langle g \rangle) \leq 0,7$	Medium
$(\langle g \rangle) \leq 0,3$	Low

Results and Discussion

A preliminary study or field study is conducted to gather information regarding the needs of chemistry teaching material in schools, particularly for the 2013 curriculum. The information is gathered from the school and chemistry teachers of the 11th grade in High School, and it is about the use of e-module teaching material and the students' critical thinking. According to the information obtained, student textbooks for subjects are only textbooks provided by the school, and not all students have access to them due to a limited number of books.

The field study is being carried out in SMAN 3 Tapung, Kampar. Based on observations and interviews with chemistry teachers, it is clear that the teachers continue to use traditional methods in their teaching activities. As a result, the students are passive and tend to listen to the teacher's lectures. Meanwhile, students require learning innovation that encompasses the use of media, appropriate learning sources, and a learning model. One of the learning tools, teaching material in the form of modules, is still used infre-

quently. In addition to the time-consuming manufacturing, it must also locate the appropriate reference. The Covid-19 pandemic struck the world, particularly Indonesia, at this time. Teachers must rack their brains to discover the proper solution in the learning process since teaching and learning activities are barred from meeting face to face immediately. In addition to field studies, literature studies are conducted to investigate and investigate the foundations of the modules used. Reading and evaluating the results of previous studies on student scientific and module development is used to conduct a literature study on the development of e-module chemistry based on phenomena in thermochemical material (Zamrizal & Doyan, 2017). A study on generative learning-oriented modules shows that they are effective for use in learning. This is seen from the students' responses of 88.90 % and the significant improvement in learning outcomes and science process skills (Novita-sari, et al., 2016).

As one of the demands of the 21st century curriculum, information technology should be used to its full potential to assist in the learning process. One of them is in assisting with printed teaching materials. In today's learning sources, the utilization of printed teaching materials is less than optimal. The usage of technology-assisted learning modules, also known as electronic modules or e-modules, has never been utilized in this school and is expected to help with existing issues, particularly in strengthening students' critical thinking skills.

A phenomenon-based e-module is one of the teaching materials in the form of a module that is packaged in digital form, of which module consists of texts, images, animations, and videos that are arranged systematically. It consists of activities, namely observing phenomena, compiling provisional explanations, investing/investigating, compiling final explanations, and providing reasons (Islakhiyah, et al., 2018); furthermore, there are indicators of critical thinking based on Robert H Ennis in (Hidayat, et al., 2016), i.e. focusing questions, analyzing arguments, answering questions that require explanation, considering the truth of the source, concluding, inducing, creating, and determining the results of the considerations, defining terms, and considering definitions, identifying assumption, and determining action.

The implementation of phenomenon-based e-module to improve the students' critical thinking skill was analyzed using independent sample t-test and normalized gain test (n-gain). Before conducting the independent sample t-test, previously the normality test was conducted to discover the data distribution. The normality test data were obtained thru a Shapiro Wilk test using SPSS 23. The significance values were presented in Table 2.

Table 2. The Test Results of Pretest and Posttest Data

Score	Shapiro-Wilk		
	Statistic	Df	Sig.
Pretest	XI MIPA 1	31	0,436
	XI MIPA 2	30	0,086
Posttest	XI MIPA 1	31	0,694
	XI MIPA 2	30	0,712

According to Table 2, it can be known that the pretest and posttest scores have a sig. score on the pretest of 0,436 and 0,086, and the sig. scores on the posttest are 0,694 and 0,712. It means that the above data have a sig. score > 0,05; thus, it can be concluded that the data are normally distributed and feasible to be used in further analysis. To see if

there are differences in the students' critical thinking skills before and after using the e-module, an *independent sample t-test* is carried out which can be seen in Table 3.

Table 3. The Results of Independent Sample T-Test

Critical Thinking Skills	T-test			Levene's Test	
	t	df	Sig. (2-tailed)	F	Sig.
	7,086	59	0,000	16,492	0,000

According to Table 3, it is known that the significance value is $0,000 < 0,05$, in which the meaning is that H_a is received and H_o is rejected. It can be concluded that there is a significant difference on the students' critical thinking skills before and after using the phenomenon-based e-module on the thermochemistry material. The improvement of students' critical thinking skills in the experimental classes is due to the fact that in the learning process using phenomenon-based e-module. The phenomenon-based e-module has several excellences i.e. the use of e-module makes the learning process fun, because the e-module is equipped with multimedia facilities such as images, animation, audio, and video. This can be seen during the learning process; the students are very active in asking questions and enthusiastic in learning the e-module material. The results of these observations are in accordance with the research conducted by (Hartini, et al., 2017), in which it reveals that the use of learning media which integrated with text, images, animation, audio, and video is effective to improve the motivation; thus, it eases the students' to understand the concept of material.

In the phenomenon-based thermochemistry e-module, it presented phenomenon in the initial activities so that the students were demanded to arrange provisional explanation related to the phenomenon. Furthermore, investigating the process of the occurrence of phenomena and related problems, followed by compiling a final explanation and ending by providing reasons that had been prepared. In addition, the phenomena presented in the e-module also added insight to the students to find out more information. This is in line with a study conducted by (Saudah, et al., 2019) which indicates that there is an improvement of students' conceptual understanding in the cognitive realm thru an implementation of phenomenon-based learning.

The data analysis of critical thinking was conducted using *N-Gain* value, of which values were used to discover the improvement category of students' critical thinking skills after using the phenomenon-based e-module on the thermochemistry material. The test analysis results of *N-Gain* values from the test results of the students' critical thinking skill after using a phenomenon-based e-module on the thermochemistry material can be seen in the following Figure 1.

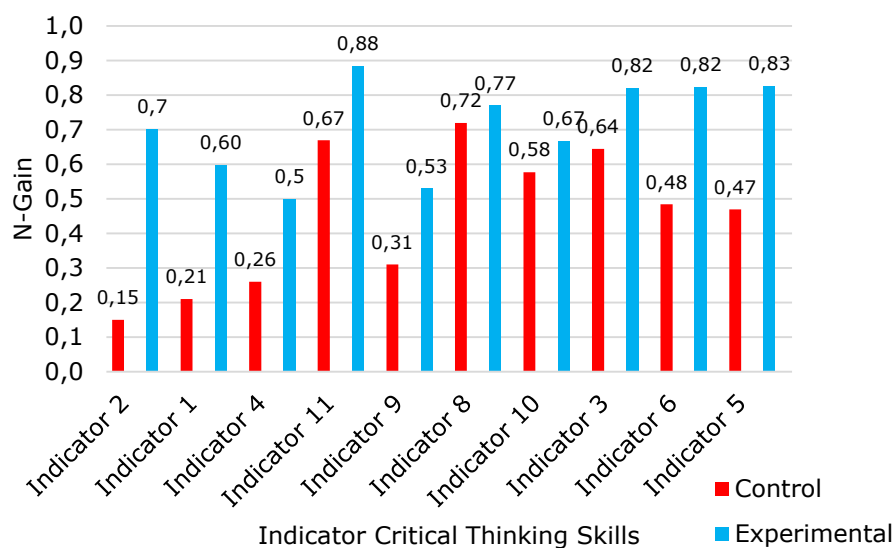


Figure 1. Results of Analysis of N-gain score in Indicators Critical Thinking Skills Test

Figure 1 indicates the categories of improvement in each indicator of students' critical thinking skills, in which it is based on the use of phenomenon-based e-module in the thermochemistry. Based on the analysis of ten indicators of students' critical thinking skills, it can be concluded that the use of phenomenon-based e-module in hydrocarbons material can affect the improvement of students' critical thinking skills.

The results of the analysis of the overall *N-Gain* value test on the critical thinking ability test of students can be seen in Figure 2.

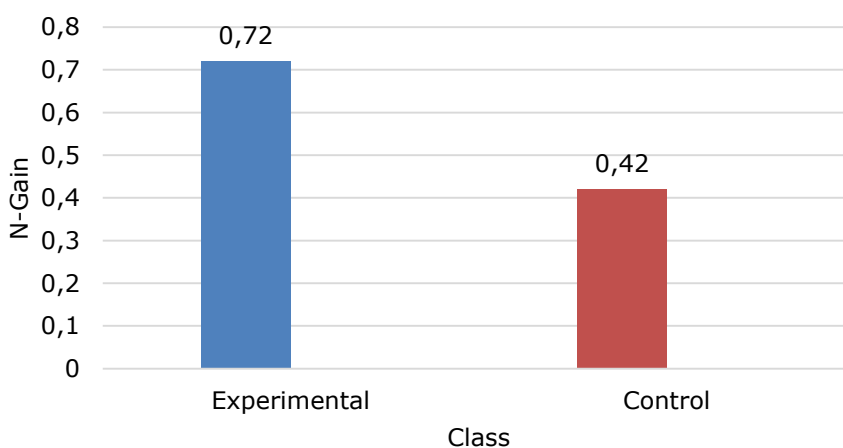


Figure 2. Analysis of N-Gain Score in Critical Thinking Skills Test

Based on Figure 2, it indicates that the N-Gain score of experimental classes (using the phenomenon-based e-module) is 0,72, included in the high category. Meanwhile, the N-Gain score of control classes (without using the phenomenon-based e-module) is 0,42, included in the medium category. Consequently, it can be concluded that the use of phenomenon-based e-module can improve the students' critical thinking skills, in which it is 0.72 in the high category. This study is also in line with the results of study conducted by

(Valanne, et al., 2012) which states that a phenomenon-based learning can assist, support, and even encourage the students to be more motivated in catching the issues and topics related to a teaching material so that it attracts the interest of students to find out information by reading. In addition, phenomenon-based learning is able to improve the students' critical thinking skills, work collaborative skills in groups, and motivate students.

The use of phenomenon-based e-module also has several advantages, namely making learning fun, because e-module is equipped with multimedia facilities, such as images, animations, audio and video. It can be seen that the learning process of students is very active in asking questions and interested in learning the material in the e-module. It also assists the students to freely study the learning materials independently. This is in line with the findings of (Laili, 2019) which says that the e-module has an important role in the learning. Learning can come off effectively; hence, it assists the students to experience difficulties during the learning process, assists the students to learn independently, being able to measure their own level of understanding and in the e-module there is also a final goal in learning activities so that the students know the learning objectives that are needed. Therefore, it should be mastered.

Phenomenon-based learning besides that it also affects the understanding of students' concepts contained in the indicators of phenomenon-based learning activities in order to rearrange the problems they get from a phenomenon. This agrees with the research conducted by (Akhir, et al., 2015) that phenomenon-based learning is learning based on direct observation so that it involves students fully in the learning process to be able to build new knowledge and explore their thinking abilities.

The use of this phenomenon-based e-module is to improve the students' critical thinking skills so that it fits the demands of the 21st Century. With this phenomenon-based e-module, it opens the students' insight that learning is not only to read and memorize material, but also practice for developing thinking skills, and be scientific so that it will increase the understanding in the material being studied. In a study conducted by (Pareken, et al., 2015) through a phenomenon-based learning, it will give freedom to the students to investigate individually or in groups in solving problems of a phenomenon given by the teacher; hence, with these activities it will begin to increase the students' critical thinking skills.

Another follow-up study conducted by (Sugiharti, et al., 2019) which states that with the implementation of learning using e-module, the results of students' critical thinking skills in experimental class 1 have an average increase of 0,829 which is greater than that of experimental class 2 and control class. In addition, a study conducted by (Serevina, et al., 2018) also shows that the N-Gain test scores of students on the pretest and posttest scores are 0.6, in which it is included in the medium category which means that there is an increase in participants' process skills before and after using the e-module.

The implementation of an e-module based on phenomena in thermochemical material can improve students' critical thinking, as evidenced by the clear, simple, and systematic learning activities offered in the e-module. As a result, learning may be implemented independently, especially during the COVID-19 pandemic, and it can be used anywhere and at any time. Students are also given the opportunity to choose their own learning rhythm (Linda et al., 2018; Dewi and Primayana, 2019). The use of an e-module based on phenomena not only displays the test but also includes pictures, animations, videos, questions, and items that help students strengthen their critical thinking skills. Thus, one of the efforts made in improving the students' critical thinking skills is the implementation of phenomena-based e-module, especially thermochemical material for class XI students of SMA Negeri 3 Tapung.

Conclusion

The implementation of phenomenon-based e-module in thermochemistry material provides a significance value of $0,000 < 0,05$, it means that H_a is received and the H_0 is rejected. Thus, it can be concluded that there is a significant difference on the students' critical thinking skills before and after using the phenomenon-based e-module in the thermochemistry material. The improvement of students' critical thinking skills is due to the fact that in the learning process the students are trained to think critically through the discovery of phenomena-based concepts in every learning activity contained in the phenomenon-based e-module. Hence, through this activity, the students are able to improve critical thinking skills such as analyzing arguments, identifying data, explaining related scientific phenomena in everyday life.

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