The Effect of Instructional Design Based on Learning Cycle 7E Model with Mind Map Technique to the Students' Critical Thinking Skills

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Abstract
Lately, the research on 21st-century competencies has become the focus on research in the world of education. Critical thinking skills has become one of the competencies to face the challenges of the 21st-century with learning model and media. This research aims to know the effect of implementing of Learning Cycle 7E Model (LCM-7E) assisted by mind map to students' critical thinking skills. This research employs quasi-experimental design with two ways ANOVA analysis technique. The instrument used to measure the critical thinking skills was an essay test that consisted of 7 questions. The result of the hypothesis shows that there is an effect of the LCM-7E model assisted by mind map toward the students' critical thinking skills. Yet, gender factors do not influence on the students' critical thinking skills.
KeyWords:
learning cycle 7E model, critical thinking skills, mind map technique, gender

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INTRODUCTION

The education world is currently facing the 21st-century challenges (Jatmiko, Kartina, Fakhri, & Pricilia, 2018; Maphosa & Mashau, 2017). 21st-century learning requires students to have critical thinking skills, creativity, digital literacy, and contextual learning (Häkkinen et al., 2016; Hikmah, Budiasih, & Santoso, 2016; Saregar et al., 2018). Also, critical thinking skills is needed by students to deal with problems in thes digital era, especially in science learning (Arsal, 2017; Purwati & Murtianto, 2018; Verawati, Ayub, & Prayogi, 2019).

One of them is physics learning which has an important role in the development of science and technology (Llorens, Berbegal-mirabent, & Llinàs-audet, 2016; Oktaningtyas & Wasis, 2018). Physics learning should be able to focus the students to master concepts by experiencing directly (Rahayu, Syafril, Wati, & Yuberti, 2017; Sharma, 2018). Thus, students' thinking skills can develop. (Eisenman & Payne, 2016).

The level of thinking skills of male and female students is diverse that is influenced by knowledge and psychology (Rosmaiyadi, 2017; Sagala, Saregar, Thahir, Umam, & Wardani, 2019). The females critical level is higher because they are more active while males are indifferentduring the learning process (Qulud, Wahidin, & Maryuningsih, 2015; Rosa, 2017). Students are also accustomed to using a few thinking skills so that they have not been able to analyze and solve problems (Putri & Supriana, 2018; Yuberti, 2015). Preliminary research results indicate that students' critical thinking is still low (Diani, Herliantari, Irwandani, Saregar, & Umam, 2019). The percentage of the critical level of male students is only 26.4% and 39% for the female students.

One of the efforts to solve this problem is by using effective learning models and media (Adiwijaya, Suarsini, & Lukiati, 2016; Mansour, 2015). Teachers as facilitators must be skilled in using learning models (Hajhosseini, Zandi, Shabanan, & Madani, 2016). Thus, the learning process can be centered on students and there is no gap between male and female students (Astra & Wahidah, 2017; Hanib & Indriwati, 2017; Rosa, 2017). Also, utilizing technology as a learning medium can motivate students to achieve learning goals (Irwandani, 2016; Kasim & Wahyuni, 2018; Sari, 2019).

The several learning models and media that are relevant for the learning process include problem-based learning (Putri & Edi, 2018), inquiry (Abdurrahman, 2017), learning cycle 7E (Naqeeb, Khalil, & Kayani, 2015) nd learning media such as mobile pocket book (Sari, 2019), web-enhanced course (Diani, Syarlisjiswan, & Yuberti, 2018), dan mind map (Kasim & Wahyuni, 2018). In this case, the researchers used the learning cycle 7e model assisted by mind map to improve the critical thinking skills of male and female students (Diani, Irwandani, et al., 2019).

The learning cycle 7e model (LCM-7E) is a learning model with a constructivism approach (Sharma, 2018). The stages in the model include elicit, engage, explain, elaborate, evaluate, and extend stages (Idika, 2015; Nuri Balta, 2014; Sharma, 2018). Students can increase learning activities and play an active role so that critical thinking skills could increase (Dewi, Wibawa, & Devi, 2017; Rosmaiyadi, 2017). Using the mind map in the learning process can sharpen memories and analyze ideas to form new knowledge (Agustyaningrum & Simanungkalit, 2016; Irwandani, 2016; Susilo Tri Widodo, 2016).

Referring to previous studies, the LCM-7E can improve learning outcomes and positive responses from students (Ade Nurhajjah, Andika Kusuma Wijaya, 2018). Also, making a link map to assist in the learning process using the LCM-7E produces good problem-solving for students (Ahmad Taufiq, 2018). The difference of this research is that the LCM-7E assisted by mind map is used to measure the critical thinking skills of male and female students. In the learning process, the stages of the LCM-7E are applied to the entire learning process with the help of the mind map. Thus, students can be more active in the learning process and able to analyze and solve problems.

Research Problem

This research is based on the weakness of students' critical thinking skills. Through the mind cycle 7e learning model, it is hoped that this map can improve students' critical thinking skills.

METHOD

This study uses the quasi-experimentalmethod with two-ways ANOVA as the analysis technique. The samples of the experimental class were 8 male students and 25 female students. The samples of the control class were 12 male students and 21female students. The instrument used was in the form of 7 essay questions to measure students' critical thinking skills. The Learning Cycle Model 7E stages are as follow (Naqeeb et al., 2015):

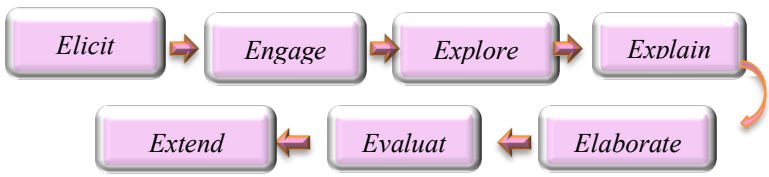

Figure 1.
Learning Cycle 7E

One example of critical thinking skills in this study is as follows:

Look at the picture below. What is the relationship between mechanical, potential, and kinetic energy on the train? Please answer using mind map!

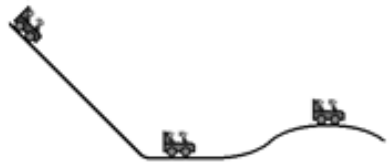

Figure 2

The Sample Problem of Critical Thinking Skills

Prediction

Observe the position of the train sliding from the top height in the picture below. Based on these problems, it can be seen that the train at point 1 at the maximum height is sliding to point 2 with minimum height and third point at medium height.

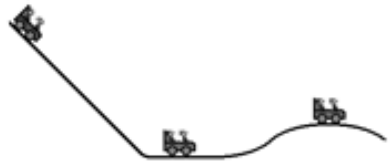

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Figure 3

The Sample Problem of Critical Thinking Skills on Mechanical Energy

Furthermore, data analysis techniques include the normality and homogeneity tests and hypothesis testing using the SPSS program.

RESULTS AND DISCUSSION

Based on the results of research usingthe same mind map media in the experimental and control class, the data analysis was performed to obtain the average values as follows:

Table 1.

Critical Level Results

Class	Total Data	Mean	Highest Score
Learning Cycle 7E	33	71.45	100
Conventional	33	59.03	89

Table 1 shows that the average score of students' critical thinking skills using the LCM-7E assisted by mind map is higher than in conventional class assisted with a mind map.

Table 2.
Results of Gender-Based Critical Thinking Skills

Group	Total Data	Mean	Highest Score
Male	20	66.10	89
Female	46	64.87	100

Table 2 shows that the mean values of gender-based critical thinking skills of male students are higher compared to female students but female students have the highest score.

Table 3.
The Normality Test

Group	Sig	Results
Experimental	0.367	Normal
Control	0.584	Normal
Male	0.573	Normal
Female	0.673	Normal

The analysis of the normality test shown in table 3 shows that the sample in each group is normally distributed.

Table 4
Homogeneity Test

Group	Sig	Results
Experimental	0.10	Homogeneous
Control	0.328	Homogeneous
Male	0.064	Homogeneous
Female	0.17	Homogeneous

The analysis of the homogeneity test shown in table 4 shows that the sample in each group ishomogeneous.

Table 5.
Hypothetical Test

Group	Sig	Results
Model	$0.01 < 0.05$	H_0 is rejected
Gender	$0.436 > 0.05$	H_0 is accepted
Model * Gender	$0.115 > 0.05$	H_0 is accepted

The ANOVA test assisted by SPSS shows the differences in students' critical thinking skills. However, there is no interaction between gender and models-gender in students' critical thinking skills The hypothesis in this study is presented in the following figure:

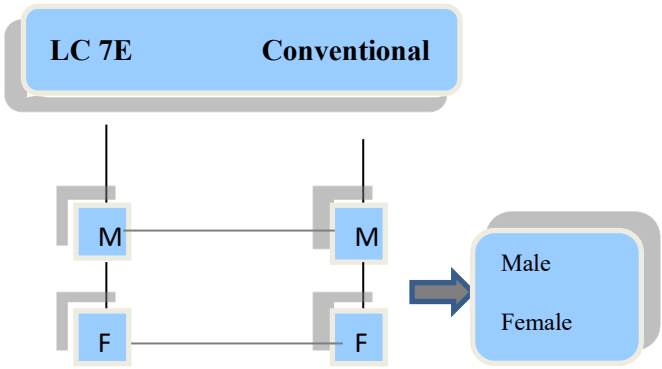


Figure 4.
Relationship of All Hypotheses

First Hypothesis

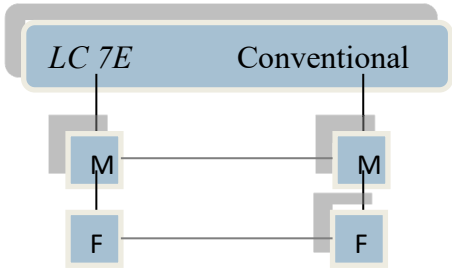
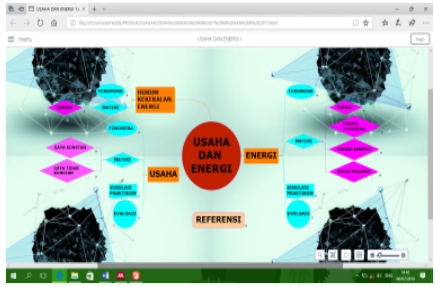
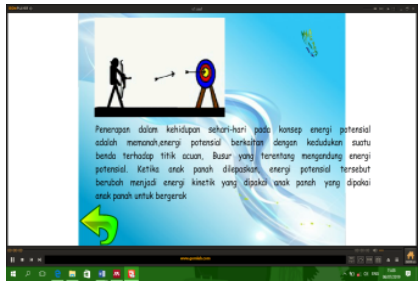


Figure 5
Learning Process Model

The average critical thinking skills score of the learning cycle 7e model is 71.45 while the average critical thinking skills score of the conventional model assisted by mind map is only 59.03. Thus, using thelearning cycle 7emodel assisted by mind map can foster students critical thinking skills (Habibi et al., 2019).

During the application of thelearning cycle 7e model, thestudents seemed to be more enthusiastic. Learners are directly involved in finding, analyzing, and solving problems (Rahmawati et al., 2019). The learning process that involves everyday phenomena makes it easier for students to analyze problems. The mind map used can stimulate students' interests. The students were enthusiastic of the display presented in mind maps such as images, animations, and interesting material (Prastowo et al., 2019). This is in line that the learning cycle 7e model influences the students'critical thinking skills (Rosmaiyadi, 2017) and the mind map has a positive impact on the learning process (Nengsih, 2016). The learning cycle 7e model assisted by the mind map used in this research are presented in the following table:

Table 6.
Learning Stages of Learning Cycle 7E Assisted by the Mind Map

Learning Phase	Learning Activities
Elicit	Teachers find out the student's initial knowledge by conducting question and answer related to the material. Students then responded enthusiastically so that class conditions began to be active. Furthermore, the mind map was presented to the students in learning.  **Figure 6.** *Mind Map Media*
Engage	The teacherintroduced new ideas and asked the students to push the tables and walls. Next, teachers directed the students to analyze the event. Furthermore, students answered confidently based on their analysis of the event. Teachers focused and attractedthe students' interest in learning usingmind map by displaying animations, images and interesting material related to force and energy.  **Figure 7.** *Animation of Mind Map*
Explore	Teachers directed the students to form groups.Teachers asked the students to discuss the problems given about potential energy in an object by looking for information as widely as possible. Students cooperated with their groups while theteachers act as the facilitators
Explain	Teachers directed each group to present the results of the discussion related to the opinions and analysis that have been

	discussed. Each group presented the results of the discussion well and the other students can respond to the presentation.
Elaborate	Teachers discussedthe conclusions about force and energy materials and their application in everyday life together with the students. Teachers used the mind map to explain the material as a whole. Students then listened carefully and enthusiastically.  **Figure 8** *Material on Mind Map Media*
Evaluate	Teachers assessed the learning process. Students were able to analyze and evaluate the problems given by teachers during the learning process. Besides, students also began to be active and dominated the learning process.
Extend	Teachers asked the students to conclude the material that has been explained during the learning process. Furthermore, teachers and students connected the concepts of force and energy with other related concepts.

Therefore, the learning cycle 7e model assisted by media map can improve students' critical thinking skills.

The Second Hypothesis

The second research hypothesis is the gender relationship toward students' critical thinking skills presented in the following figure:

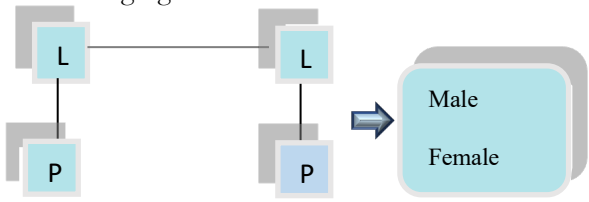


Figure 9.
Gender and Learning Process Relationship

The hypotheticaltest shows that there is no difference in the critical thinkingskills in male and female students. However, the average score of male students is higher than the average female students. This is in line with previous research that the average critical level of male students is higher than female (Resty & Mufti, 2019). Theresults of the mind map between male and female students in

solving critical thinking questions do not show any significant differences (Huda, Tsani, Syazali, Umam, & Jermsittiparsert, 2020). This can be seen in the following image.

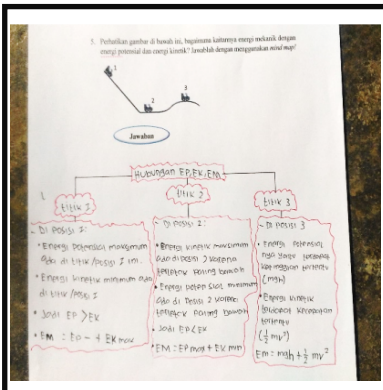


Figure 10
Male Students' Answer

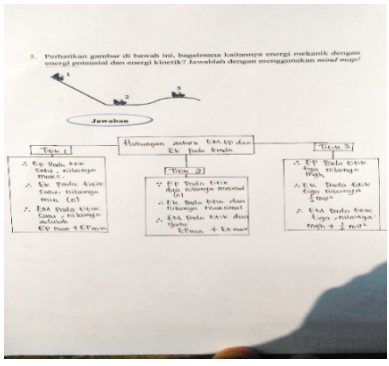


Figure 11
Female Students' Answer

Thus, the results of the critical thinking skills between male and female students are not too significant. These results are the same as previous studies (Farianti, Rahmi, & Agustina, 2016) that there is no influence of gender on critical thinking skills.

The Third Hypothesis

The third hypothesis in this study is that there is no interaction between the learning models with the gender on the critical thinking skills(Hartinah et al., 2020). The average critical thinking skills of the participants reviewed based on the learning models assisted by mind map is relatively similar between male and female students. This is presented in the following figure:

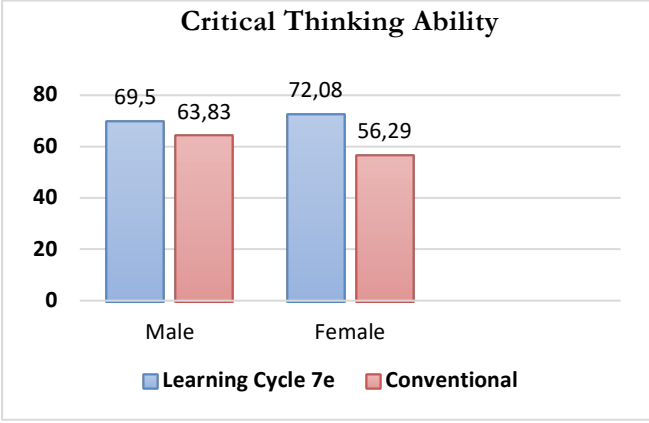


Figure 12.
Critical Thinking Skills

Figure 12 shows that the average score of the critical thinking skills of male students using different learning models is relatively the same. However, the average score of the critical thinking skills of female students with thelearning cycle 7E model is higher than the conventional model. Thus, the learning cycle 7E model can stimulate students'critical thinking skills. These results are the same as previous studies that there has not been an interaction between learning models and gender (Resty & Mufti, 2019). The aspect that causes no interaction on genders and the learning model is that the students were not concentrating during the learning process.

DISCUSSION AND CONCLUSION

Based on the data analysis and discussion, the average score of students using thelearning cycle 7E model is higher than the conventional model, so, itcan influence the students' critical thinking skills. Furthermore, the critical thinking skills of male and femalestudentsare comparable. Thus, gender does not affect students' critical thinking skills. Besides, there is no interaction between learning models and gender on students' critical thinking skills (Diani, Herliantari, et al., 2019).

Differences in students' critical thinking skills between the experimental class and the control class occur due to several factors other than treatment with the application of the learning cycle 7E learning model. Although these factors have been minimized, there are only a number of factors that are advantages and disadvantages in terms of teaching both in the control class and in the experimental class. Learning in the experimental class at each meeting is less conducive and tends to be noisy if the class is not controlled by the students' screams (Habibi et al., 2019). This is because learning in the experimental class is carried out in the afternoon after the midday prayer. The condition of the hot room and the physicality of students who have not eaten is one obstacle for the learning flow in the classroom. But this can be anticipated by the way the teacher gives games or ice breaking so that students can refocus learning. Every now and then the teacher brings food in the form of mint candy so that students become relaxed again (Lestari et al., 2019).

Internal factors of students that students still feel awkward and ashamed to explore their activeness in learning. While the external factors of students that occur because the classroom is hot and uncomfortable because learning time is carried out during the day, so that good learning conditions have not been created. This is a correction for the next meeting so that the learning environment in the classroom can be managed to support the optimal application of the 7E learning cycle learning model and positive student activity is increased. The first meeting is filled with material characteristics and classification of mosses (bryophyta) and ferns (pteridophyta). The application of learning begins with questions and directions or instructions from the teacher to carry out the discussion. It aims to determine the extent of student knowledge about the material to be taught. Furthermore, students'

critical thinking skills are sharpened by active discussion in observing the samples of ferns and mosses that have been provided. At first students look stiff and ashamed to express ideas or opinions, but at a later stage students are not reluctant when discussing because at the elaboration stage, each student is required to fill out student activity sheets.

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Attachments

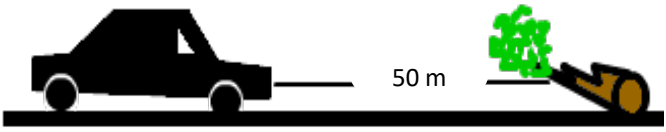
PRETEST-POSTTEST

Critical Thinking Skills

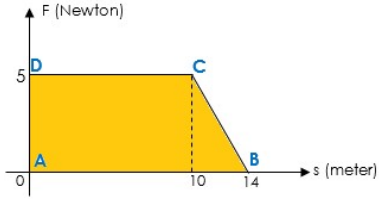
1. The baseball is placed at the end of a table. How big is the potential energy of the baseball at points 1,2, and 3. Answer it using the mind map!

2. Rina stated to Masaji that when she was driving by driving her car twice as fast, it meant that she needed a stop distance of 2 times the original distance. In your opinion, is Yuda's statement true? Tell!

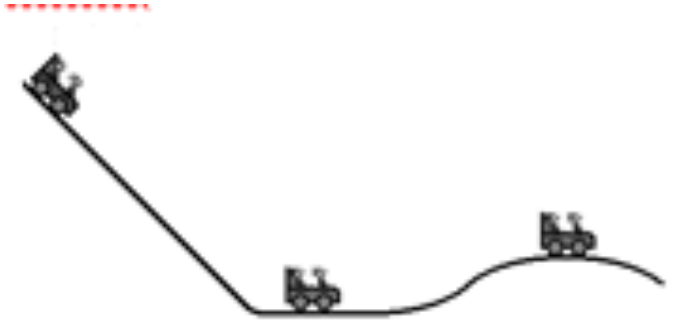
3. Dul drives a mobile car with a mass of 4000 kg with a speed of 36 km / hour. Suddenly in the middle of the trip there was a fallen tree at a distance of 50 m. How much braking force is needed so that the car driven by Dul does not hit the fallen tree?



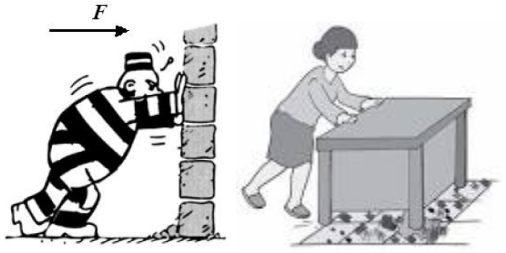
4. A beam with a mass of 50 gr moves along a straight line on a horizontal surface due to the influence of the changing force on position as shown in the figure. Calculate the effort made by the force to move the beam as far as 14 m.



5. Pay attention to the picture below, how is the relationship between mechanical energy with potential energy and kinetic energy? Please answer using a mind map!



6. Nathan pushes with a force of 50 N. But the wall still doesn't move, while Agnes pushes a table with a force of 10 N. Is it true that Nathan's effort is bigger than Agnes?



7. A 10 kg iron ball with vertical free fall from a height of 2 m of sand. If the object enters 2 cm deep into the sand before stopping, what is the average force applied by the sand to block the object?