



## The Effect of the 5E Learning Cycle Model on the Critical Thinking Skills of Junior High School Students in Learning Science

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### Abstract

Critical thinking skills are very important to be acquired by the students in the 21st century. In science learning, students are required to think critically. However, students' critical thinking skills at the junior high school level are included in the low category. The 5E learning cycle model is the learning model that is considered can train the student's critical thinking skills optimally. The purpose of this study was to examine the effect of the 5E learning cycle model on junior high school students' critical thinking skills in science learning and to describe the improvement of junior high school students' critical thinking skills. This type of research is experimental research with a quasi-experimental design and nonequivalent (pretest and posttest) control-group design. The results of the study for the effect test using the independent sample t-test obtained the value of Sig. (2-tailed) of 0.016 which means  $<0.05$ . The implication is that the 5E learning cycle model has a significant effect on the thinking skills of junior high school students in learning science. For the improvement test using N-Gain, an average N-Gain of 0.5875 was obtained which was included in the moderate category, then the results of the paired sample t-test obtained a Sig value. (2-tailed) of 0.000 which means  $<0.05$ . The conclusion was the 5E learning cycle model has a significant effect on junior high school students' critical thinking skills in science learning and it can improve junior high school students' critical thinking skills in the moderate category.

**Keywords:** 5E learning cycle model, critical thinking skills, science learning

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## INTRODUCTION

Critical thinking skills are competencies that have to be mastered by students. Critical thinking is a skill in analyzing and evaluating information to draw a valid conclusion (Agustine et al., 2020). Critical thinking is essentially a cognitive process that is carried out through the activity of comparing existing knowledge in order to determine more correct knowledge to solve the problems (Rahmawati, 2022). The concept of critical thinking implies one's involvement in the knowledge construction process through reflection and thinking deeply (Saleh, 2019). It can be seen by looking at it's characteristics that are able to respond to the problems by making the right decisions from an analysis, organizing, digging up information based on the facts rationally, and compiling the correct, precise, and systematic arguments (Nurjaman, 2021). We also can measure the someone's critical thinking skill by looking at it's indicators. As for the indicators of critical thinking consists of interpretation, analysis, conclusions, evaluation, explanation, and self-regulation (Facione, 2015).

Critical thinking skills are needed by students to face challenges in the 21<sup>st</sup> century. The 21<sup>st</sup> century education is an era of comprehensive and dynamic education that requires students to have the ability to solve various phenomena and challenges (Jannah et al., 2023). The 21<sup>st</sup> century classroom requires students to face real-world problems that involve them in critical thinking (Živković, 2016). Critical thinking skills makes students agile in comparing, analyzing, and dealing with problems (Qomariyah, 2017). Critical thinking can support students to improve their ability in mastering the material, selecting and sorting the information, expressing the arguments or reasons, and solving problems (Supeno et al., 2018). Next, critical thinking skills also make students proficient in solving various challenges (Nasihah et al., 2020). In addition, the 2013 curriculum requires students to be able to think critically. These critical thinking skills are very important because these competencies make the students not immediately receive the information obtained, but they have to analyze and evaluated first (Mustofa, 2018). By having critical thinking skills, students can reach the standard competencies that are formulated and ready to compete in the future.

Critical thinking skills are very important for students in learning science. It is closely related to the process of looking the knowledge and understanding about the nature in a systematic way which implies the existence of concepts or theories that must be understood comprehensively. Therefore, students are required to think critically to construct the knowledge through an active role in learning (Putri et al., 2021). Science learning is inseparable from scientific and systematic investigations (Masruhah et al., 2022). In science learning, students need critical thinking skills so that they can understand the science materials easily, have the readiness to solve problems in daily activities, and make the right decisions based on the understanding of science and technology (Sulaeman, 2020). Problem-solving or finding the right solutions for problems is one of how critical thinking and science are interrelated (Santos, 2017). Problems that occur in daily human life is related to the nature, thus students need to have critical thinking skills while learning the science. It helps the students to solve problems in the best way (Wardhani, 2018). The science learning is focused on gaining direct experience by using the critical thinking skills.

Students' critical thinking skills at the junior high school level are included in the low category. This statement is supported by the research conducted by Utomo et al. (2020) which was carried out at one of the state junior high schools in Jember Regency. It found that the students had low indicators in critical thinking. Students were passive during learning and the learning material was delivered only by the teacher. Research conducted by Ridho et al. (2020) also revealed that the results of measuring critical thinking skills in junior high school students in science subjects were 35.2%, which was in the low category. Besides, based on the Programme for International Student Assessment (PISA) score which published in 2018 by The Organization for Economic Co-operation and Development (OECD), Indonesia was ranked 72 out of 78 participating countries. In the field of science, Indonesia gets a score of 396, it was lower than the OECD average score of 489 (Schleicher, 2018). Students need to think critically to complete the PISA test. the PISA item test are identified with problems encountered in daily life, then students are encouraged to think critically through various methods to find the causes and draw conclusions (Lestari et al., 2021). Therefore, teachers need to innovate the learning process to familiarize students with critical thinking, such as through the use of learning models that lead to the attainment of critical thinking skills.

One of the learning model that can direct students to achieve critical thinking skills is the inquiry learning model. It is widely recognized that the inquiry learning model aims to improve students' higher-order thinking skills such as critical thinking skills, due to student involvement through hands-on and minds-on activities (Chen, 2021). The research of Eskris (2021) revealed that the Discovery Learning model could improve critical thinking skills. However, this model had a weakness, namely that many students were confused in the process of finding it and students could not follow the learning steps (Asri & Noer, 2015).

Meanwhile, Prasetyo & Rosy (2021) revealed a model that could improve critical thinking skills in Inquiry Learning. However, this model also had weaknesses that it was less effective to be applied in classes with many students and with average intelligence (Shoimin, 2017). Furthermore, Darwati & Purana (2021) showed a model for increasing the critical thinking skills namely Problem-based Learning (PBL). However, this model had a weakness that without an understanding of the problem, students were less motivated in learning and this model could not implemented very well (Hamruni, 2012). The discovery learning model that can be applied optimally is the 5E learning cycle model because the learning phases in this model correspond to a series of stages in the learning cycle.

The 5E learning cycle model can train critical thinking skills. This statement is supported by research by Kuba et al. (2020) who revealed that the 5E learning cycle model has a significant effect on critical thinking skills in junior high school students. The results of his research revealed that the critical thinking skills of the experimental class which were given treatment in the form of applying the 5E learning cycle model got a higher score than the control class. Agree with Irhamna et al. (2017) revealed that the 5E learning cycle model could be an alternative teacher to improve students' skills in critical thinking. In addition, the study by Wati et al. (2021) revealed that the implementation of the 5E learning cycle model in science learning had a significant effect on critical thinking skills. The application of the 5E learning cycle model has a positive impact on critical thinking skills in junior high school students.

The advantages of the 5E learning cycle model over conventional learning models which only focus on the lecture learning method are found in student activity, where learning using the 5E learning cycle model is student-centered. The 5E learning cycle model demands an active role for students in learning, including encouraging students to collaborate and have direct contact with the surrounding environment to analyze various phenomena that occur in life (Syaidah et al., 2017). Not only that, the 5E learning cycle model encourages students to construct their concepts in the discovery process and encourages them to apply understood concepts to new conditions (Ma'arif et al., 2020). Meanwhile, Ajaja (2013) revealed two main limitations in the 5E learning cycle model. First, this model requires a lot of time because it involves as many as 5 phases which makes it less suitable for achieving learning objectives directly. Second, students who depend on the teacher for all the information and direction can have difficulty learning. However, these two limitations can be reduced by increasing teaching time and re-emphasizing strong collaboration between students when applying the 5E learning cycle model to science learning.

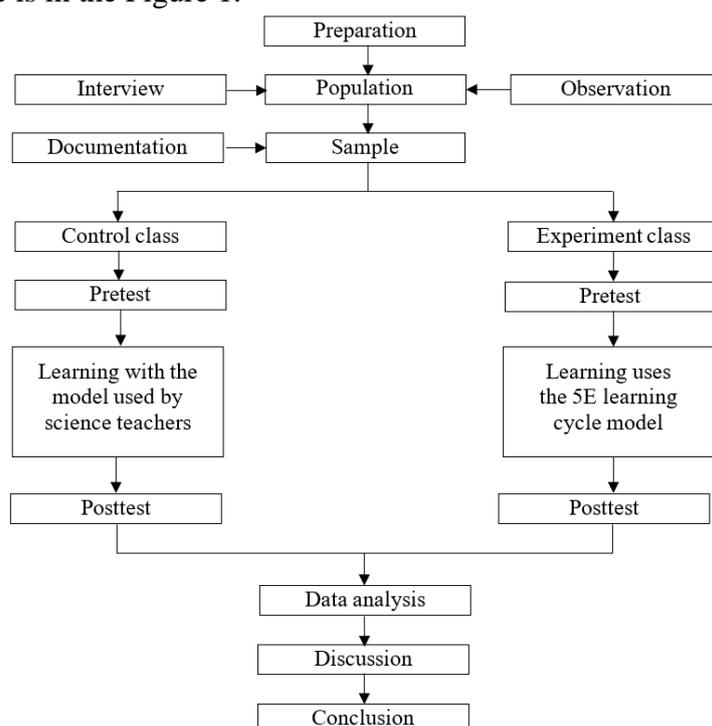
Learning that utilized the 5E learning cycle model includes five phases or cycles for student learning. The five phases include engagement, exploration, explanation, elaboration, and evaluation (Latifa et al., 2017). In the engagement phase, the teacher attracts the students' interest toward the material that will be learned and gains the prior knowledge of the students. Furthermore, in the exploration phase, students are motivated to propose new hypotheses, make observations or practicum, and record the observed data. Afterwards is the explanation phase where the student tries to explain the concepts that obtained from the previous phase by using their own sentences also providing the evidences. In the elaboration phase, students apply the concepts that have been understood into new conditions in order to get the meaning of the learning. Eventually in the evaluation phase, students can assess themselves by asking questions about concepts they have not understood (Cahyani et al., 2021). Each phase of the 5E learning cycle model creates effective and efficient teaching and learning activities that can practiced by the students to be skilled in critical thinking.

An alternative solution can be taken to overcome the low critical thinking skills of junior high school students in science learning is by applying the 5E learning cycle model. The differences of the research conducted by the researcher with previous researchers are in the selection of subject matter, method, and the place of research. Kuba et al. (2020) researched the 5E learning cycle model on the subject of Energy in Life Systems for Class

VII and used a quasi-experimental method with a posttest-only control group design to examine the effect of the 5E learning cycle model on students' critical thinking skills at SMPN 9 Kupang Timur. Furthermore, Irhamna et al. (2017) researched the subject Static Fluid for Class VIII and used a pre-experimental method with a one-group pretest-posttest design to describe the increasing of students' critical thinking skills after learning by using the 5E learning cycle model at SMP Torsina Singkawang. Different from this research that used the subject of the Structure and Function of Plants for Class VIII and a quasi-experimental method with a pretest-posttest control group design to examine the effect of the 5E learning cycle model on students' critical thinking skill. This research described the improvement of students' critical thinking skills after learning by using the 5E learning cycle model at SMPN 7 Jember. The research that concerned in critical thinking skills is very important to be conducted because it becomes an asset for students to develop their knowledge widely. Further research is needed to test previous research related to the effect of the 5E learning cycle model on critical thinking skills. The purpose of this study was to examine the effect of the 5E learning cycle model on the junior high school students' critical thinking skills in science learning and describe the improvement of junior high school students' critical thinking skills after learning using the 5E learning cycle model.

## METHOD

This research is experimental research with a quasi-experimental design. The design used is a nonequivalent (pretest and posttest) control-group design. The subject of this study was class VIII students at SMPN 7 Jember for the 2022/2023 academic year. The sample selection used a purposive sampling technique which included the experimental class and the control class. The experimental class chosen was the class VIII-E and the control class chosen was the class VIII-F. Participants involved were 31 participants in class VIII-E, and 32 participants in class VIII-F. The sample was selected based on the criteria outlined by the researcher, including the sample being homogeneous, the sample being willing to do the pretest to measure students' initial critical thinking skills, and the sample being willing to do the posttest to measure students' critical thinking skills after treatment. The research was conducted at SMPN 7 Jember in the odd semester of the 2022/2023 academic year. The research procedure is in the Figure 1.



**Figure 1.** Research flowchart

The data collection techniques were carried out by test and non-test. The tests were given in the form of a pretest and a posttest. The pretest and posttest questions consisted of 6 items which covered 6 indicators of critical thinking skills, namely interpretation, analysis, conclusion, evaluation, explanation, and self-regulation. The validation of pretest and posttest questions was carried out by competent experts to provide an assessment of the validity of questions that have been made. The test instrument which consisted of 6 essay questions has been declared valid and feasible to use. Meanwhile for the non-test used observation, interview, and documentation methods. Observations were carried out to find out the condition of the students, the learning model usually used by the teacher, and the availability of school facilities. The interviews were aimed to get overviews of the science learning activities that are usually carried out by the teachers in the class, including models, methods, and learning media. The documentation were collected that consisted of the names of students class VIII at SMPN 7 Jember in the 2022/2023 academic year, previous material test scores, pretest scores, posttest scores, photos, and videos of learning activities during research in the experimental class and control class.

The data analysis techniques that used in this study consisted of homogeneity test, normality test, independent sample t-test, N-Gain test, and paired sample t-test. The homogeneity test aims to see that the variance between the two classes is homogeneous. The homogeneity test was carried out with the SPSS application in version 26 that used the t-Anova test based on pretest data. If the significance  $\geq 0.05$  (Sig.  $\geq 0.05$ ), then the variances of the two classes are homogeneous. If the significance is  $< 0.05$  (Sig.  $< 0.05$ ), then the variances of the two classes are not homogeneous. The resulting pretest data is calculated using the following formula:

$$Result = \frac{Total\ score}{Maximum\ score} \times 100\%$$

The resulting percentages are then interpreted based on the category of critical thinking skill level in the Table 1.

**Table 1.** Category level of critical thinking (Agnafia, 2019)

Percentage	Intervals
81% - 100%	Very high
61% - 80%	High
41% - 60%	Enough
21% - 40%	Low
0% - 20%	Very low

The normality test was carried out to see whether data used in this study were normally distributed or not. The normality test was carried out using the Kolmogorov-Smirnov test. The assumptions of data analysis are normally distributed or not can be known through the result of Kolmogorov-Smirnov values. If the p-value  $> 0.05$  significance level ( $p > 0.05$ ), then the research data is normally distributed. If the p-value  $<$  a significance level of 0.05 ( $p < 0.05$ ), then the research data is not normally distributed (Hulu & Sinaga, 2019).

The independent sample t-test aims to determine the significance of the effect of using the 5E learning cycle model on critical thinking skills. The data used were based on the posttest scores that obtained from the experimental class and the control class. If the calculated value ( $p$ )  $> 0.05$ , then there is no significant difference in the average score of critical thinking skills between the experimental class and the control class. If the calculated value ( $p$ )  $< 0.05$ , then there is a significant difference in the average score of critical thinking skills between the experimental class and the control class (Endra, 2017).

Normalized Gain (N-Gain) aims to determine the increasing of students' critical thinking skills after learning activities by using the 5E learning cycle model. The data used in this test were the pretest and posttest scores of the experimental class. Data analysis with N-Gain was calculated by using the following formula:

$$\langle g \rangle = \frac{\% \langle S_f \rangle - \% \langle S_i \rangle}{100 - \% \langle S_i \rangle}$$

Information:

$g$  : N-Gain value

$S_f$  : average final score of critical thinking skills (posttest)

$S_i$  : initial average score of critical thinking skills (pretest)

High- $g$  : class with  $\langle g \rangle \geq 0.7$

Medium- $g$  : class with  $0.7 < \langle g \rangle \geq 0.3$

Low- $g$  : class with  $\langle g \rangle < 0.3$

The paired sample t-test was carried out to determine the increasing of students' critical thinking skills after learning activities by using the 5E learning cycle model. Data regarding to the initial critical thinking skills were taken from the experimental class pretest results, while data regarding to the critical thinking skills after treatment was taken from the experimental class posttest results. If the calculated value ( $p$ )  $> 0.05$ , then there is no significant difference between the pretest scores and posttest scores after treatment. If the calculated value ( $p$ )  $< 0.05$ , then there is a significant difference between the pretest scores and posttest scores after treatment.

## RESULTS AND DISCUSSION

Data of the students' critical thinking skills in the experimental class and control class were obtained from the results of the pretest and posttest. The instrument used in assessing the critical thinking skills includes 6 indicators, namely interpretation, analysis, conclusion, evaluation, explanation, and self-regulation. The average score of students' critical thinking skills based on each indicator can be seen in the Table 2.

**Table 2.** Data on students' critical thinking skills scores for each indicator

Indicator	Pretest				Posttest			
	Experiment		Control		Experiment		Control	
	Average	Category	Average	Category	Average	Category	Average	Category
Interpretation	92.47	Very high	76.34	High	100	Very high	69.89	High
Analysis	46.24	Enough	54.84	Enough	80.11	High	47.85	Enough
Conclusion	3.58	Very low	11.11	Very low	81	Very high	65.95	High
Evaluation	4.30	Very low	0	Very low	70.43	High	68.82	High
Explanation	2.15	Very low	0	Very low	50.54	Enough	46.24	Enough
Self-regulation	0	Very low	0	Very low	40.86	Enough	35.27	Enough

Based on the Table 2, the first indicator, namely interpretation, showed that the average score achieved by the experimental class is higher than the control class. The experimental class got an average score of 100 which was categorized as very high, while the control class got an average score of 69.89 which was categorized as high. Interpretation is the ability to understand and communicate the meaning of experience, data, or events (Facione, 2015). The experimental class could achieve a higher interpretation score because interpretation had been practiced in the exploration phase. In this phase, students were directly involved to the

environment and were confronted with data or events that required to express the meaning of these data or events. The exploration phase in the 5E learning cycle model leads students to bring up indicators of interpretation and analysis during inquiring the phenomena. This phase can train the students to formulate the problems and prove the hypotheses by conducting experiments and analyzing experimental data (Kustianingsih & Muchlis, 2021).

The second indicator is analysis. From the results of the analysis indicators, it can be seen that the average score achieved by the experimental class is higher than the control class. The average score of the experimental class was 80.11 which was categorized as high, while the average score of the control class was 47.85 which was categorized as sufficient. The analysis is the ability to determine the actual inferential relationship between statements, issues, or other forms of representation to communicate reasons, data, or arguments (Facione, 2015). The experimental class was able to achieve a higher analysis score because, in the engagement phase, students were accustomed to analyze the previous knowledge and experience with the information or facts that presented by the teacher. Furthermore, in the exploration phase, students were carried out the activities to analyze experimental data (Gazali et al., 2015). Besides, in the explanation phase, they were also required to analyze the arguments that put forward by their friends by identifying the reasons of a concept. Habituation during the learning process influences the analysis indicators.

The third indicator is conclusion. From the results of the conclusion indicators, it can be seen that the average score achieved by the experimental class is higher than the control class. The average score of the experimental class was 81 which was categorized as very high, while the average score for the control class was 65.95 which was categorized as high. The conclusion is the identification ability to make rational decisions by taking into account relevant data and reducing the consequences that arise from data, statements, or other forms of representation (Facione, 2015). The experimental class could achieve a higher-conclusion score because in each meeting the investigation was designed to direct the students to build conclusions. In the explanation phase, students explained the results of their observations, related them to the concepts, and made conclusions based on the observations which showed the conclusion indicator (Kustianingsih & Muchlis, 2021). In the elaboration phase, students applied the concepts which they already understood in order to identify and obtain the elements needed for making a conclusion. In addition, they also were carried out the concluding activities at the end of the activity (Latifa et al., 2017).

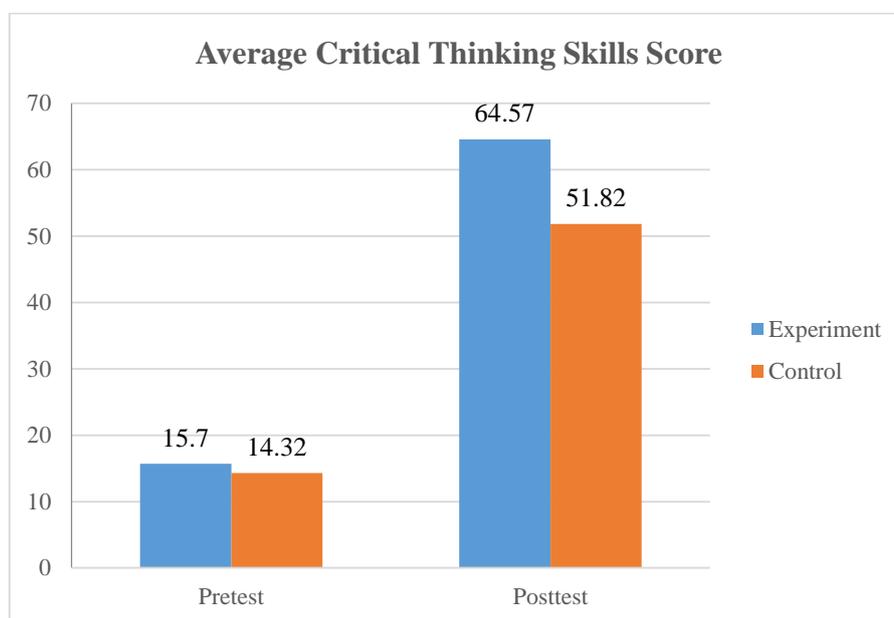
The fourth indicator is evaluation. The results of the evaluation indicators showed that both classes received scores that were categorized as high, but the average score achieved by the experimental class was higher than the control class. The average score of the experimental class was 70.43, while the average score of the control class was 68.82. The evaluation is the ability to assess the validity of a statement or other form of representation that describes one's understanding or decision and assesses the actual inferential relationship between statements, issues, or other forms of representation (Facione, 2015). The experimental class could achieve a higher evaluation score because the elaboration phase facilitated the students to apply each concept that they had learned toward the new conditions which raised the evaluation indicators in order to measure student knowledge (Kustianingsih & Muchlis, 2021). Furthermore, in the evaluation phase, students also evaluated their progress in achieving learning objectives.

The fifth indicator is explanation. The results of the explanation indicators showed that both classes received scores that were categorized as enough, but the average score achieved by the experimental class was higher than the control class. The average score of the experimental class was 50.54, while the average score of the control class was 46.24. The explanation is the ability to express reasoning in evidence and present reasoning through persuasive arguments (Facione, 2015). The experimental class could achieve a higher explanation score because, in the explanation phase, the students presented their arguments related to the knowledge that had been obtained in the previous exploration phase. The

explanation phase required students to analyze the existing arguments by identifying the reasons for certain concepts (Latifa et al., 2017).

The sixth indicator is self-regulation. The results of the self-regulation indicators showed that both classes received scores that were categorized as enough, but the average score achieved by the experimental class was higher than that of the control class. The average score of the experimental class was 40.86, while the average score of the control class was 35.27. Self-regulation is the ability to observe one's cognitive activity and the results that had been taught, especially by applying skills to analyze and evaluate one's own inferential to confirm or correct one's results (Facione, 2015). The experimental class could achieve a higher self-regulation score because self-regulation had been trained in the elaboration and evaluation phases. In the elaboration phase, students applied their understanding and skills to the new situations. In addition, the evaluation phase exercised the self-regulation by analyzing and applying the knowledge and skills for self-evaluation related to understanding concepts (Zakiyah & Lisdiana, 2022).

The average scores of pretest and posttest for all indicators in the experimental class and control class showed some differences. The results of calculating the average scores of pretest and posttest for the experimental class and the control class are shown in Figure 2.



**Figure 2.** Diagram of the overall average score of critical thinking skills

Based on Figure 2, it can be seen that the average pretest score of the two classes is very low, namely 15.70 for the experimental class and 14.32 for the control class. The level of students' initial critical thinking skills is at the lowest level. The low pretest scores for both classes were because the two classes had never been practiced in critical thinking skills. In addition, the two classes had not yet received Plant Structure and Function material for the junior high school level. However, after the experimental class was given the treatment, namely the use of the 5E learning cycle model, there was a significant change. The average posttest score achieved by the experimental class was 64.57 which was in the high category. The average posttest score achieved by the control class was 51.82 which was categorized as sufficient. The final critical thinking skill level of control class students is at the one level below the experimental class.

Furthermore, a statistical test was carried out namely an independent sample t-test to see the effect of the 5E learning cycle model on junior high school students' critical thinking skills in learning science. Prerequisite test was carried out previously, namely the homogeneity test and the normality test. The homogeneity test results can be seen in Table 3.

**Table 3.** Homogeneity test results

		Levene			
		Statistic	df1	df2	Sig.
Pretest Score	Based on Mean	2.398	1	61	.127
	Based on Median	1.626	1	61	.207
	Based on Median and with adjusted df	1.626	1	60.880	.207
	Based on trimmed mean	2.509	1	61	.118

The normality test results are shown in Table 4.

**Table 4.** Normality test results

		Pretest_	Posttest_	Pretest_	Posttest_
		Experiment	Experiment	Control	Control
N		31	31	32	32
Normal Parameters <sup>a,b</sup>	Mean	15.6990	64.5697	14.3225	51.8222
	Std. Deviation	5.26687	22.95783	4.53790	17.57910
Most Extreme Differences	Absolute	.154	.145	.146	.110
	Positive	.118	.127	.146	.110
	Negative	-.154	-.145	-.132	-.090
Test Statistic		.154	.145	.146	.110
Asymp. Sig. (2-tailed)		.060 <sup>c</sup>	.096 <sup>c</sup>	.080 <sup>c</sup>	.200 <sup>c,d</sup>

a. Test distribution is Normal.  
b. Calculated from data.  
c. Lilliefors Significance Correction.  
d. This is a lower bound of the true significance.

Based on the results of the homogeneity test in Table 3, showed that the two classes, namely the experimental class and the control class, are homogeneous with a significance value of 0.127, which means  $\geq 0.05$ . Based on the normality test results in Table 4, it is known that both data groups and classes are normally distributed with a significance value for the experimental class pretest of 0.060, for the experimental class posttest of 0.096, for the control class pretest of 0.080, and for the control class posttest of 0.200, which means  $> 0.05$ .

### The Effect of the 5E Learning Cycle Model on the Critical Thinking Skills of Junior High School Students in Learning Science

Because of the prerequisites for normally distributed data were acquired, it can be continued with the independent sample t-test by using SPSS application in version 26. The results of the independent sample t-test are showed in the Table 5.

**Table 5.** Independent sample t-test results

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Posttest Score	Equal variances assumed	3.471	.067	2.479	61	.016
	Equal variances not assumed			2.469	56.209	.017

Based on Table 5, it can be seen that the difference of treatment that had been given between students in the experimental class and the control class resulted in a difference in the average posttest score achieved. The average posttest score achieved by the experimental class was 64.57, while the average posttest score achieved by the control class was 51.82. Based on the results of the independent sample t-test, the significance value of Sig. The F test is 0.067. It means that the variances of the two data are homogeneous because of  $0.067 > 0.05$ . Furthermore, the significance value of Sig. (2-tailed) obtained was 0.016 that are less than 0.05. It means there is a significant distinction toward the average score of critical thinking skills between the experimental class and the control class. Thus, it can be said that the 5E learning cycle model has a significant effect on the critical thinking skills of junior high school students in learning science. Because of the average posttest score of the experimental class is higher than the control class, it can be concluded that the posttest results of the experimental class are better than the control class.

The difference result in the posttest between the experimental class and the control class indicates that the 5E learning cycle model is effective to be used in practicing the students to be skilled in critical thinking. The indicators of critical thinking skills that have to be achieved by students are widely applied to learning using the 5E learning cycle model. Therefore, It makes the model are effective to build students' critical thinking skills. After students go through each phase in the 5E learning cycle model and interact with the environment or peers, students can define, organize, modify the original concept, and elaborate (Chen, 2021). This statement is in line with research by Hartawati et al. (2020) who showed that the 5E learning cycle model guided the students to discover concepts, understand, and apply these concepts in daily life in order to stimulate their critical thinking skills. The primary phase of practicing critical thinking skills is in the elaboration phase because in this phase students are required to develop every concept they have learned into a new conditions that can encourage them to think more critically (Mustofa, 2018). The elaboration activities carried out in each lesson makes the students to get used with classifying, analyzing, and evaluating concepts that obtained in the previous phase. In other words it can practice the students to be skilled in critical thinking (Gazali et al., 2015).

For the control class in this study, there were two indicators that showed the average posttest score were decreasing from the average pretest score, namely interpretation and analysis indicators. The interpretation indicator were decreasing because some students gave an incorrect answer while mentioning the type of leaf reinforcement based on the picture. The students were careless in observing the pictures that presented in the questions. As for the analysis indicators of the several options presented in the table, the students only focused on the xylem tissue which plays a role in the movement of water from the roots to the tips of the leaves. Whereas should be, water is first absorbed by the root hairs and then forwarded to the new cortex tissue to enter the xylem. The decreasing of average score of the posttest for these two indicators can occur because of the students were less motivation. They felt bored and wanted to end the test quickly. Similar to the research by Prayitno et al. (2017) that the boredom while learning caused the decreasing of student motivation. It happened toward the control group because there was no practical activity in learning like in the experimental group. Ultimately, it made the learning achievement in the control class decreasing.

The results of observations in the control class showed that students tended to be passive, the questions that appeared were less varied, and students were less able to answer the questions correctly. In contrast to the experimental class where students were very active in the learning process, various questions emerged, and students were able to answer the questions correctly with their reasoning. Learning that took place in the control class applied the discovery learning model that using the discussion method with the media in the form of photos and video. Students worked in groups in order to answer the student worksheets and discuss the material based on the results of a literature study. As the result, it made the students became less interested in participating the lesson and tending more passive.

However, these problems can be overcome by appointing students to ask questions or respond to the questions from the teacher.

### Improving Critical Thinking Skills for Middle School Students After Learning Using the 5E Learning Cycle Model

Because of the prerequisites for normally distributed data were acquired, it can be continued with the N-Gain test and paired sample t-test using SPSS application in version 26. The results of the calculation of the N-Gain test are in the Table 6.

**Table 6.** The n-gain test results

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	31	.17	.90	.5875	.25456
Valid N (listwise)	31				

Furthermore, the paired sample t-test was carried out to support the results of the N-Gain test. The results of the paired sample t-test are shown in the Table 7.

**Table 7.** Results of the paired sample t-test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest Score – Posttest Score	48.87065	20.37427	3.65933	-56.34399	-41.39730	-13.355	30	.000

Based on the average score of the pretest and posttest of the experimental class, there was a significant enhancement. The experimental class got an average pretest score of 15.70, then an average posttest score of 64.57. The N-Gain test results in Table 6 obtained an average N-Gain Score of 0.5875. Because  $0.7 < 0.5875 \geq 0.3$  it is proven that there is an improvement in students' critical thinking skills after learning by using the 5E learning cycle model and the improvement is in the moderate category. This is also supported by the results of the paired sample t-test in the Table 7 which gets a significance value of Sig. (2-tailed) of 0.000. Because  $0.000 < 0.05$ , there is a significant difference between the pretest scores and posttest scores after the treatment. Thus, it can be concluded that the students' critical thinking skills after learning using the 5E learning cycle model is increasing.

The results of improving students' critical thinking skills in the experimental class indicated that the 5E learning cycle model was able to involve students during the learning process optimally. The model made the students active in gaining the knowledge with a series of activities that guided them in constructing their knowledge. Critical thinking skills are present in processes related to scientific methods or research, such as observation, exploration, and in the process of knowledge construction (Santos, 2017). This activity improves the critical thinking skills. This statement is in line with Snyder et al. (2008) in Latifa et al. (2017) that a learning environment which demands the students' activeness in investigating and applying the knowledge that has been acquired can improve students' critical thinking skills. The process of involving students through the cognitive activities during the learning process can practice their critical thinking skills (Rusydi et al., 2018). Improving skills in critical thinking requires activeness and proficiency in analyzing and evaluating the existing information to produce the best answers that can be obtained (Wayudi et al., 2020).

The result of this study are in line with the results of Kuba et al. (2020) where in the experimental class the average posttest score was 86.32, then in the control class the average posttest score was 76.24. The results of the t-test show that the 5E learning cycle model has a significant effect on building the critical thinking skills. Another supporting research is study

that conducted by Irhamna et al. (2017) with the conclusion that implementing the 5E learning cycle model can improve the critical thinking skills and the improvement is in the moderate category. In this study, the average score of the pretest and posttest were 50.25 and 66.5 respectively.

Implementing the 5E learning cycle model in this study experienced some problems at the first meeting. The students were less conducive when observing plants in the school environment. This happened because the students at SMP Negeri 7 Jember never had studied outside the classroom. Learning that usually carried out by the teacher emphasizes on the discussion activities in the classroom by using picture and video media. The solution is to provide direction regarding the activities to be carried out besides explaining the observation steps contained in the student worksheets, remind the students to work in groups, and help the students when they found difficulties in the field. The overall learning activities can be done very well and the obstacles that occurred can be resolved properly.

## CONCLUSION

Based on the description of the results of data analysis and discussion, the conclusion of this study is that the 5E learning cycle model has a significant effect on the critical thinking skills of junior high school students in learning science. Science learning by using the 5E learning cycle model can improve the critical thinking skills of junior high school students in the medium category. The 5E learning cycle can be an alternative learning model for teachers to practice and improve students' critical thinking skills.

## RECOMMENDATION

For further research it is recommended to apply the 5E learning cycle model to practice and improve students' critical thinking skills in other subjects. Students who are less conducive when carrying out the observation and practicum activities can affect the research results. Therefore, teachers are expected to provide direction regarding the activities to be carried out and re-emphasize strong cooperation between students so that the steps in student worksheets are carried out optimally and knowledge can be well captured.

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