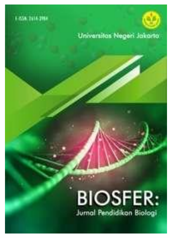
Biosfer: Jurnal Pendidikan Biologi, 13 (1), 86-100 (2020)

Biosfer: Jurnal Pendidikan Biologi

Journal homepage: http://journal.unj.ac.id/unj/index.php/biosfer



Getting critical thinking about ecosystem: How impact and responses of students about the CirGi learning model?

Lia Junita Harahap[1*], Rizhal Hendi Ristanto[1], Ratna Komala[2]

[1] Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Indonesia
[2] Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Indonesia

*Corresponding author: liajunita52@gmail.com

ARTICLE INFO

Article history
Received: 15 February 2020
Revised: 18 April 2020
Accepted: 28 April 2020

Keywords:
CIRC
CirGi
Critical thinking skills
Ecosystem
Guided inquiry

ABSTRACT

The broad scope of biology and the many sources of biology reading requires eleven grade students to think critically about sorting out information to develop and support students' critical thinking skills. CirGi is an integration of the cooperative integrated reading and composition (CIRC) learning model and guided inquiry (GI) that emphasizes reading and writing activities, accompanied by guidance from the teacher. This study aimed to analyze the influence of CirGi's learning model on students' critical thinking skills. This research uses a quasi-experiment method with pre-post control group design. The sampling technique used purposive sampling, namely 104 high school students. Data collection was carried out using instruments of critical thinking skills in the form of essays, questionnaire responses of students to learning, and observation sheets of syntax implementation. The data analysis technique used was one-way ANCOVA. After controlling for the pretest scores, the CirGi learning model's influence on students' critical thinking skills was influenced. This learning model was appropriate for learning biology, so it can regrow the activities of reading science books that impact students' critical thinking skills.

Harahap, L. J., Ristanto, R. H., & Komala, R. (2020). Getting critical thinking about ecosystem: How impact and responses of students about the CirGi learning model?. *Biosfer: Jurnal Pendidikan Biologi, 13*(1), 85-100. https://doi.org/10.21009/biosferjpb.v13n1.86-100

INTRODUCTION

Natural science is expected to give positive benefits in daily life. Biology, as one of the science disciplines, is a science that studies about the organism (Torkar & Krašovec, 2019; Septiana, Miarsyah, & Komala, 2017). Biology is fascinating to study since it closely relates to self, processes occurred in the body, interaction between organism and environment (Ristanto, Zubaidah, Amin, & Rohman, 2018). Current biology learning requires critical thinking skills as it is in line with the 21st-century demand (Osman, Hiong, & Vebrianto, 2013; Teo, 2019). Biology education development in school is under technology development that makes student skills to think critically (Ristanto, Djamahar, Heryanti, & Ichsan, 2020; Bustami, Riyati, & Julung, 2019). Critical thinking skill is one of the skills needed to solve various problems. It involves logical thinking, interpreting, analyzing, and evaluating information to obtain reliable and valid decision or conclusion (Crittenden, Biel, & Lovely, 2018; Ku, 2009; Dwyer, 2014).

Critical thinking skill is required to improve students' proficiency and cognitive skill; it is related to ability to analyze the logic and evaluate problem-solving (Facione, 1999; Erikson & Erikson, 2018; Elder, 2001; Widana, 2018). It can be interpreted as the application of intellectual values such as relevance, accuracy, and strict reasoning (Carlson, 2013; Dahl, 2018). Critical thinking skill not only illustrates thinking that following logic and probability rules, but also describes the ability in applying the skill significantly (Karakoç, 2016; Noviyanti, Rusdi, & Ristanto, 2019). The importance of empowering critical thinking skills has encouraged various studies conducted by researchers to improve students' critical thinking skills with various successes (Abrami et al., 2008; Adam & Manson, 2014; Bustami et al., 2019).

Aspects needed in critical thinking include asking relevant questions, defining problems, investigating problems, analyzing assumptions, synthesizing information, drawing a conclusion, and making reasonable arguments (Facione, 2011; Espey, 2017). Students who have critical thinking skills will be able to solve problems, open-minded, effective in communication (Tofade, Elsner, & Haines, 2013; Paul & Elder, 2006). Further information on inquiry that has been received or studied has the self-confidence to present new perspectives or insights, active, creative, right in time management, and have analytical and synthesis thinking (Karakoç, 2016; Ristanto et al., 2020). The absence of these skills will make students lose their competitiveness in the globalization era (Trilling & Fadel, 2009) and struggle to compete in the work environment (Permana et al., 2019).

Students' critical thinking skill in ecosystem concepts is still low (Irwan, Maridi, & Dwiastuti, 2019; Musyaddad & Suyanto, 2019). The low critical thinking skills among students can be indicated by students who responding to question in a short answer, suggesting that they are unable to develop the question-answer (Ristanto et al., 2020). Besides, students are unable to analyze questions; thus, the responses are mostly undirected, or students are only filling in answer to each question (Miharja, Hindun, & Fauzi, 2019). It is consistent with Fauzi (2019) and Suyamto, Masykuri, & Sarwanto (2018) that students' critical thinking skills in several Biology contents are still low. Efforts to improve the skills could be conducted by using active learning models instead of depending on the lecture, writing, memorizing, and and not merely focusing on the content (Crittenden, 2010). An effort to improve students' critical thinking skills is by applying an appropriate learning model (Mabruroh & Suhandi, 2017; Bustami et al., 2019). The use of an active learning model in Biology learning could improve students' critical thinking skills (Noviyanti, et al., 2019; Bustami et al., 2019; Ristanto et al., 2020).

CIRC learning model is an active learning model that emphasizes reading and writing activities (Ristanto et al., 2018; 2020). Students conduct the activities entirely and compose them into important parts (Slavin, 2005; Megamaya, Putra, & Zulaikha, 2014). CIRC also assists students in learning to cooperate in a group during reading, writing, and language art at a higher level (Ekawati, 2016; Ristanto et al., 2018).

Students in eleven grade study the ecosystem at the secondary school level. The teaching of ecosystem material requires high analytical skills, and practice or application expected in daily life (Musyaddad & Suyanto, 2019; Komala, Suryanda, & Lismana, 2016). Ecosystem education discusses the relationship between organism and environment. Waiting for content from the teacher is not sufficient to achieve ecosystem learning objectives optimally. Therefore, resurrect reading activity is essential to have a more meaningful discussion process. Reading is not the best way to learn science (Robertson, 2013; Ristanto et al., 2018b). Science learning activity should involve students' investigation process to find and develop a science concept (Ristanto et al., 2018a; Noviyanti et al., 2019).

In addition to CIRC, an active learning model proven to be effective in Biology learning is guided inquiry (GI). GI learning model gives more emphasis on students to find a concept or information from various sources or teacher (Wartono, Hudha, & Batlolona, 2018; Mulyana, Rusdi, & Sigit, 2018; Siregar et al., 2019). It is believed to help students to be more active in learning Biology. The biology teacher plays a role in determining problems and directing students' ideas to achieve learning objectives (Ristanto et al., 2017). Biology teachers can also empower students' critical thinking skills by giving questions or problems that challenge students to think critically (Wartono, Hudha, & Batlolona, 2017; Kurniawati et al., 2014). A functional biology teacher should teach good thinking and a good sample or model to understand concepts learned (Tishman & Perkins, 1993; Dilekli & Tezci, 2020). The CIRC and GI learning models have good potential for Biology learning. The integration of CIRC and GI (CirGI) is expected to support and complement one another and optimizes students' critical thinking skills.

CirGi learning is developed by Ristanto et al. (2019) for Biological education. Various studies have proven a significant influence of CIRC learning model implementation in Biology teaching (Ristanto et al., 2018). There is no study, however, that integrates CirGI and aims to find out its effect on critical thinking skills in ecosystem concepts as well as to learn senior high school students' responses. This research aimed to analyze the influence of the CirGI learning model and students' response to CirGI learning in ecosystem concepts.

METHODS

Research Design

The research uses quantitative research with a descriptive approach that was designed using a quasi-experiment research method (Sugiono, 2012). The research design used the Pretest-posttest control group design.

Table 1

Pretest-posttest control group design constellation.

Class	Pretest	Treatment	Posttest
E	O_1	X	O_2
C	O_3	-	O_4

Note: E=Experimental class (CirGi); C= Control class (conventional); O_1= Pretest of experimental class; O_2= Posttest of experimental class; O_3=Pretest of control class; O_4=Posttest of control class; X=Treatment

Population and Sample

The research population is 105 eleven-grade students of a private senior high school in Depok, Indonesia of the academic year of 2018-2019. The sampling technique used Yamane (1967) formula with a precision level of 1%. Based on formula calculation, 104 students obtained as the research sample. By using a purposive sampling technique, 52 students were selected to be in an experimental class taught using the CirGI learning model, and 52 other students were control class taught using conventional learning. The grouping was based on a balanced academic grade between the classes (Table 2).

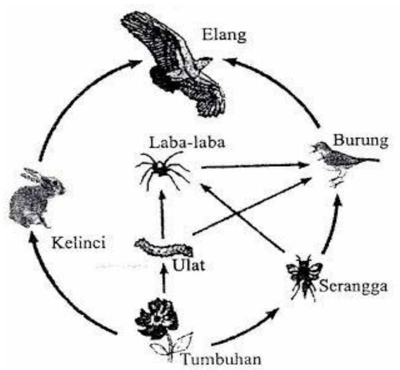
Table 2
Number of samples, each class

Treatment Class	Class	Number of Students
Experiment 1	X Natural Science 1	26
Experiment 2	X Social Science 1	26
Control 1	X Natural Science 2	25
Control 2	X Social Science 2	27
Total		**104**

Instrument

Instrument test was conducted using construct and content validity tests with an average of 81.03. The value indicated that instruments were fit to be used. Empirical validation test of instrument items used Pearson Product Moment formula. r_{count} was higher than r_{table} in a minimum range of 0.325 showed that of 15 questions tested, there were 10 valid questions. Furthermore, the reliability test measured using Alpha Cronbach obtained a value of 0.855 meant that the instruments were reliable. Instruments to measure critical thinking skills were essay tests with indicators referring to Facione (1999) as presented in Table 3.

Table 3
Critical thinking skill indicators in ecosystem concept.

Indicator	Description	Number of questions	Sample of Question
Interpretation	Understand and group various data, procedures or criteria	1	The interdependence relationship always exists in nature both between organism and between organism and its environment. One of the relationships is a predator-prey relationship known as a food chain. How many food chains are formed in the following food network image? Write down the food chains! 
Analysis	Recognize the real relationship between questions, experiences, information and test ideas	1	Conduct experiments using two soil piles. Soil pile I am planted with grass in a specific time, whereas soil pile II is not planted with grass. When both soil piles are watered, the soil pile I is destroyed, whereas the soil pile II is still intact. Based on the experiment, please explain the cause of landslide!

<table>
<tr><td>Inference</td><td>Ability to select elements needed to draw the conclusion that can answer the hypothesis by considering relevant information</td><td>2</td><td>Look at the experimental results below!
<table><tr><td rowspan="2">Month</td><td colspan="2">Number of fruit</td></tr><tr><td>Clay</td><td>Sand</td></tr><tr><td>1</td><td>9</td><td>3</td></tr><tr><td>2</td><td>17</td><td>8</td></tr><tr><td>3</td><td>25</td><td>9</td></tr></table>
Students plant two chili plants from the same species in different planting media: clay soil and sand. Based on the data, how is the chili growth in clay soil compared to sand?</td></tr>
<tr><td>Evaluation</td><td>Rate statements and quality of concepts, opinions, situations, and other representation forms</td><td>1</td><td>There are several types of insects in a flower park, including bee, grasshopper, butterfly, borer, and whitefly. Which insects must ~~that~~ be eradicated so as not to damage flowers and which insects to be kept? Explain your reasons!</td></tr>
<tr><td>Explanation</td><td>Ability to state results and present concepts in the form of proper and convincing arguments</td><td>2</td><td>Pay attention to the organism interaction below!
 
A B
An ecosystem is composed of interacting components. Explain the interaction pattern between components occurred in Figure A and B!</td></tr>
<tr><td>Self-regulation</td><td>One's awareness in monitoring his/her cognition process, self-improvement in applying skills</td><td>2</td><td>Global warming has been a world problem. One of its impacts is the melting of arctic ice in the north and south poles that causes an increase in sea level. As a consequence, many lands on earth are inundated. What efforts could be made to reduce the impact of global warming?</td></tr>
</table>

Procedures

Before ecosystem learning was conducted, students in the experimental and control classes were given a pretest to measure their initial ability. The experimental class then was taught by using the CirGi learning model in the first, second, and third meetings in September 2019. The application steps refer to Ristanto et al. (2018), as indicated in Figure 1. Control class, on the other hand, was taught by using conventional learning, which was teacher-centered learning. The post-test of critical thinking skills was then given to the experimental and control classes. Next, the students' responses were analyzed.

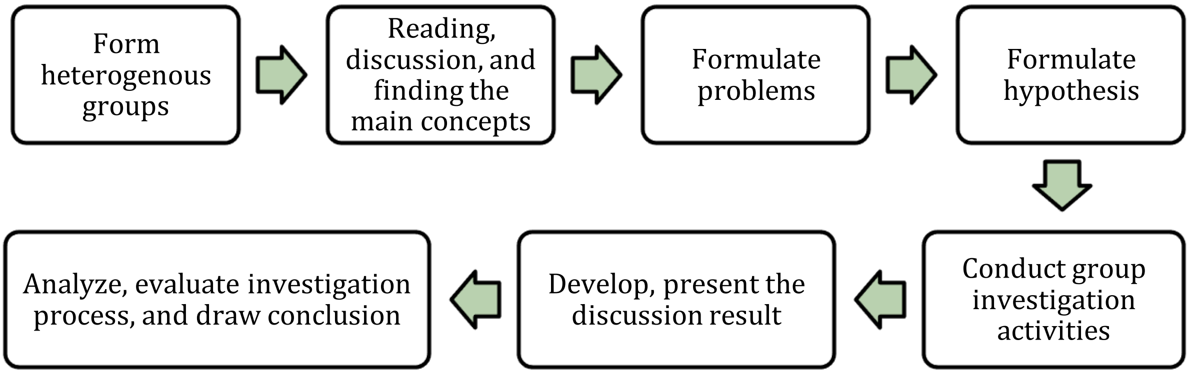


Figure 1. CirGi syntax.

Data Analysis

Data were analyzed by using the descriptive test, analysis prerequisite test, correlation test, and hypothesis test. The descriptive test was conducted by calculating the average pretest and post-test of each indicator score of students' critical thinking skills. The data analysis prerequisite test used the normality test, which was Kolmogorov-Smirnov, whereas the homogeneity test used the Levine test. The Pearson Product Moment was used for the correlation test. The hypothesis test was done using One-Way ANCOVA assisted with SPSS 25 for windows.

RESULTS AND DISCUSSION

Based on the research result, descriptive statistics that consisted of a mean score, maximum value, and minimum value from the experimental and control classes are presented in Table 4.

Table 4
Descriptive statistics of critical thinking skills.

Indicator	**CirGi**		**Conventional**	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Total Score	308.89	494.22	311.05	469.71
Mean	51.48	82.37	51.84	78.29
Min	41.59	75.72	41.11	71.39
Max	75.72	90.14	76.68	88.22
Standard Deviation	7.74	5.91	7.48	6.74
Variance	59.96	35.04	56.00	45.47

According to analysis, students who were taught by using the CirGi learning model had a higher score than students who were taught by using conventional learning, with a mean of 82.37. Before the implementation of CirGi in ecosystem teaching, the average achievement of the students in critical thinking skills was 51.48 (Table 5).

Based on the result of critical thinking skill scores, it can be seen that the post-test scores in all indicators experiences an increase in both classes, experimental and control. In the experimental class, the highest score was in the self-regulation indicator of 90.14, whereas the lowest score was an explanation of 75.72. After being taught by using the CirGi model, students were able to interpret, analyze, infer, evaluate, and explain ecosystem concepts in the aspects of ecosystem component, interaction in an ecosystem, type of ecosystem, energy flow, and biogeochemical cycle.

Table 5
Average critical thinking skills each indicator with the implementation of CirGi and conventional learning model .

No	Indicator	CirGi		Conventional	
		Pretest	Posttest	Pretest	Posttest
1	Interpretation	50.48	84.62	51.92	80.29
2	Analysis	47.12	82.45	47.12	71.63
3	Conclusion	48.80	81.49	49.52	80.77
4	Evaluation	45.19	79.80	44.71	77.40
5	Explanation	41.59	75.72	41.11	71.39
6	Self-regulation	75.72	90.14	76.68	88.22

Post-tests in the conventional class increased, but in some aspects, the scores were still low, such as in analysis and explanation aspects that achieved only a score of 71% each. Due to the discussion process conducted in the control class less optimal, and it had not been able to foster students' curiosity on problems to be solved; thus, they had not been able to analyze and evaluate ecosystem concepts appropriately. Also, it was related to the non-existence of components of formulating problems and hypotheses in the student worksheet. The learning focused on the undirected discussion process between groups; hence, students were less encouraged to think critically. It could be observed during the presentation where some group members who presented chose to silent and depended on the group leader to present and answer questions from members of other groups.

Based on the increase in pretest to post-test scores, the class with CirGi implementation had higher scores. The class had a score difference of 31.01, whereas the conventional class had a score difference of 26.52. In the CirGi class, the analysis indicator was an indicator with the most significant increase, whereas the self-regulation indicator had the lowest increase (Figure 2).

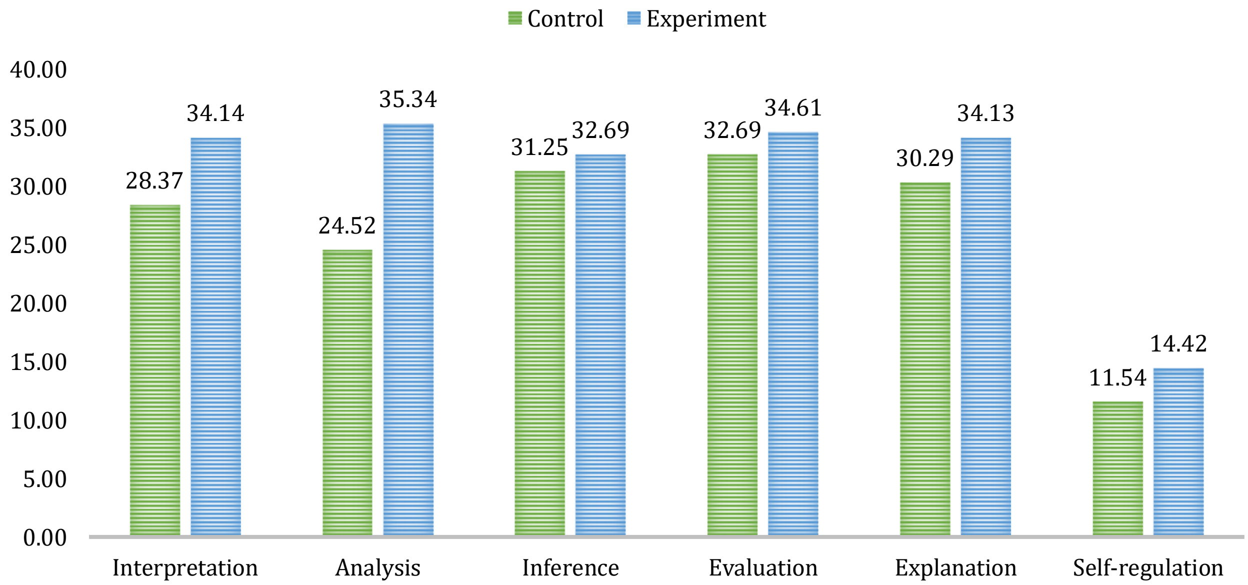


Figure 2. Differences in increase each indicator in critical thinking skill pretest and posttest.

Figure 2 indicates that the CirGi class was better than the conventional class. Students with CirGi learning implementation were already more critical in responding to environmental issues in the self-regulation aspect. They, however, needed to be accustomed to the indicator of explaining content or problem in detail and critically. It is supported by data on the result of student response to the implementation of CirGi in Table 6.

Table 6
Student Response to Learning

No.	Response	Percentage (%)			
		SA	A	D	SD
1	Forster students' interest in reading	49,00	48,00	3,10	0
2	Develop critical thinking skills	49,00	47,00	4,30	0
3	Facilitate the mastery of ecosystem concept	53,00	45,00	2,00	0
4	The learning leads to a student center	55,00	43,00	2,00	0
5	The existence of discussion	54,00	42,00	4,00	0
6	The existence of guidance from the teacher	71,00	28,00	1,10	0
7	Attitude to care about the environment	53,00	46,00	1,40	0
	Mean	54,86	42,71	2,56	0

Note: SA (Strongly Agree); A (Agree); D (Disagree); SD (Strongly Disagree).

Agreement score in indicator of capable of developing critical thinking skills achieved 49.00 for strongly agree category and 47.00 for agree category. Therefore, 96.00 students indicated that CirGi was capable of improving students' critical thinking skills. It could also be observed in changes in students' attitudes in criticizing articles/reading materials. Ability to analyze properly made students more confident to explain and communicate the discussion results. The CirGi syntax in research was also well implemented from the first to the third meetings, with an average 94% (Figure 3).

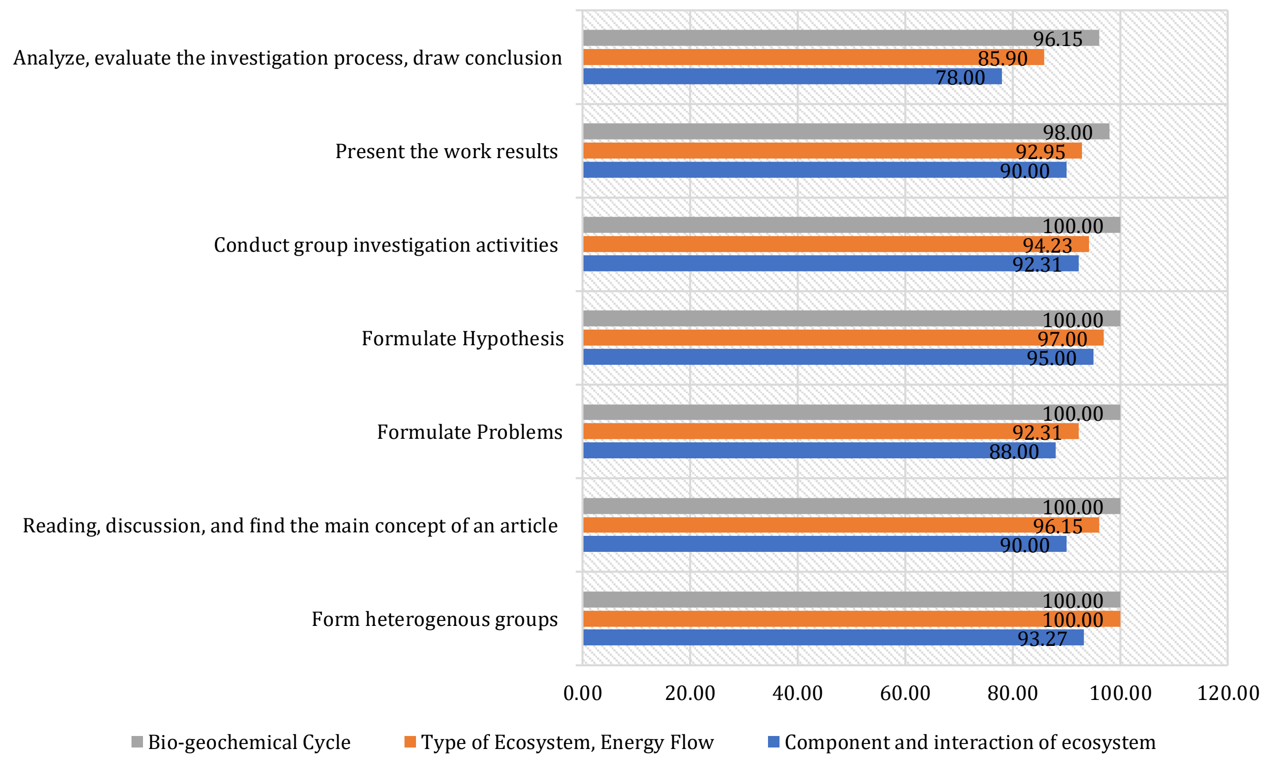


Figure 3. Percentage implementation syntax of CirGI.

Table 7
Normality of critical thinking skill pretest and posttest.

No	Class	Sample	Critical Thinking Skills		Significance	Conclusion
			Sig. Pretest	Sig. Posttest		
1	Experiment	52	0.268	0.534	0.05	Normal
2	Control	52	0.254	0.260	0.05	Normal

The result of normality test calculation in Table 7 suggests that the p-value or significance of pretest and post-test in the experimental class and control class was more significant than α=0.05; thus, the critical thinking skill data were normally distributed.

Table 8
Homogeneity of critical thinking skills.

Levene Statistic	df1	df2	Sig.
1.729	1	102	.191

Based on Table 8, the calculation result obtained a significance of 0.191 > 0.05, or H_0 was accepted. Therefore it could be interpreted that the average pretest and post-test in student groups taught by using the CirGi learning model and student groups taught by using the conventional learning model was homogeneous.

Table 9
Correlation of pretest and posttest scores of critical thinking skills.

No	Class	N	r	Sig.	Description
1	Experiment	52	0.331*	.017	Significant
2	Control	52	0.342*	.013	Significant

According to data of the experimental and control classes in Table 9, the pretest score, which is a covariate, had a significant correlation with the post-test score after treatment since the p-value or significance was smaller than α=0.05.

Table 10
ANCOVA test of critical thinking skills.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	906.407[a]	2	453.203	12.560	.000
Intercept	9115.239	1	9115.239	252.623	.000
Pretest	461.936	1	461.936	12.802	.001
Learning Model	464.691	1	464.691	12.879	.001
Error	3644.314	101	36.082		
Total	675762.500	104			
Corrected Total	4550.721	103			

Based on the data analysis conducted, the hypothesis test used ANCOVA with α=0.05. Table 10 indicates the calculation result of the learning model variable where p-value=0.001 < α=0.05, thus rejecting H_0. After controlling the pretest scores, which meant without pretest scores, at a confidence level of 95%, there was an influence of CirGi and conventional learning model implementation on critical thinking skill post-test scores obtained by students. It suggested that post-test scores obtained by students were indeed due to the influence of implemented learning models instead of student experience or because they had previously learned the ecosystem material.

The achievement of CirGi's influence was higher than conventional learning models since CirGi syntax was more supporting the ecosystem material than conventional learning. The learning syntax in both CirGi and conventional classes had a discussion activity. In the CirGi class, the learning teacher provided a student worksheet that was suitable for the CirGi syntax model to optimize students' critical thinking skills. On the contrary, in the conventional class, students worked on tests in the student handbook; thus, it was not maximal in measuring students' critical thinking skills. It could be seen in the several critical thinking indicators that had not to achieved.

Additionally, the discussion process in the experimental class was guided by the teacher. According to Probosari (2015), teachers are a leading factor in the success of Biology learning in senior high school. Rabgay (2018) adds that teacher as a facilitator will motivate students to compete between groups; hence, each group will try to present their best result that impacts the learning achievement according to target. During the discussion, students might bring books or supporting articles or articles given by the teachers related to the material. Knowledge of the ecosystem of each group will subsequently be more vibrant, and it will guide them in sharpening their critical thinking skill to solve problems. Discussion component in student worksheet included CirGi syntax in formulating a problem, formulating a hypothesis, conducting an investigation, and developing the work.

The formulating problem stage could train critical thinking skills in the interpretation aspect since the teacher conducted a question and answer session and guided students to formulate problems related to problems to be solved. The existence of inquiry was able to trigger the students' critical thinking; thus, they became more open to new ideas, care about the result, and also the process to achieve the result. Due to problem formulation, students were guided to formulate relevant hypothesis to the problem formulation. Each group discussed and conveyed ideas to formulate a hypothesis on ecosystem-based on each member's knowledge following a guide from the teacher in determining the priority of hypothesis in the inquiry. The formulating hypothesis stage was capable of training critical thinking skills in analysis and conclusion aspects (Masitoh, 2017). Students in a group analyzed the reasons for each member before setting a hypothesis. After considering opinion and determining ideas from the group members, students collected information from various sources, such as provided articles, articles from the group members, or books related to the ecosystem, so that they were able to strengthen the hypothesis.

The stage of investigating to solve the problem was able to train students' critical thinking skills in the analysis and explanation aspects (Masitoh, 2017). The group members collected information and pieces of evidence from several kinds of literature that could answer the problems. Next, students were able to find and develop their knowledge concept and ended at the stages of analyzing, evaluating, and drawing a conclusion. Students analyzed problems thoroughly before presented them. It is in line with Erikson & Erikson (2018) that presentation is an effective and beneficial way to improve students' communication skills that impacts their critical thinking skill improvement. The teacher, along with the students, evaluated the discussion results from each group in the form of questions, validation or correction, confirmation and ended with a conclusion drawing from the discussion process. Conclusion drawing could train students' critical thinking skills in the aspect of conclusion and self-regulation. Students who think critically will have self-confidence and be able to explore the implications of the conclusion made.

In the control class, the teacher, as a facilitator, had less contribution to the learning process. She only gave direction at the beginning of a meeting and in the initial activity. It triggered students to take valuable points from the book for a presentation. The group members did not understand what they presented. Some groups were still incorrect in composing the concept to be presented. It was inaccurate since an incorrect concept had shaped in the students' memory before any correction or validation from the teacher.

The group who had a presentation was unable to answer questions from other groups. It indicated that the discussion was not well managed, especially in the planning stage that caused the implementation stage did not run well; thus, it affected the achievement of learning targets. According to Gupta & Ahuja (2014) and Espey (2017), the teacher as a facilitator is critical in encouraging students to initiate discussion and to ask questions for clarification. Also, Jarmita (2012) states that teachers in a group discussion must assist students in finding an answer with their mindset. The importance of developing students' thinking process is also consistent with Vanicheva (2015) that critical thinking in science is essential since each data from the scientific facts are continued to be updated, and the update requires critical thinking process.

CONCLUSION

The use of the CirGi learning model in senior high school students of Class X could improve students' critical thinking skills in ecosystem material. After controlling the pretest scores, CirGi had a significant influence on students' critical thinking skills. Students also provided positive responses or agreement to the use of the CirGi learning model that able to improve critical thinking skills. The implementation of CirGi could direct and foster students' interest in reading science books. On the other hand, it also required much time. Therefore, it must be implemented per syntax and the pre-determined time allocation of each syntax to obtain the maximum critical thinking skills of the students.

ACKNOWLEDGMENT

The authors would like to convey our sincere gratitude to Mrs. Antik Handayani as the school principal, Mrs. Rosita Primasari as the biology teacher and students who are permitted to conduct the research.

REFERENCES

Abrami, P. C., Bernard, R. M., Borokhovski, E., Wadem, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. *Review of Educational Research*, *78*(4), 1102–1134. https://doi.org/10.3102/0034654308326084

Adam, A., & Manson, T. M. (2014). Using a pseudoscience activity to teach critical thinking. *Teaching of Psychology,* 41(2), 130–134. https://doi.org/10.1177/0098628314530343

Bustami, Y., Riyati, Y., & Julung, H. (2019). Think talk write with pictured cards on human digestive system: impact of critical thinking skills. *Biosfer: Jurnal Pendidikan Biologi*, *12*(1), 13-23. https://doi.org/10.21009/biosferjpb.v12n1.13-23

Carlson, S. C. (2013). Instructional methods influence critical thinking: do students and instructors agree? *Academy of Educational Leadership Journal*, *17*(1), 27-32. Retrieved from https://www.questia.com/library/p150920/academy-of-educational-leadership-journal

Crittenden, W. F., Biel, I. K., & Lovely, W. A. (2018). Embracing digitalization: student learning and new technologies. *Journal of Marketing Education, 41*(1), 5-14. https://doi.org/10.1177/0273475318820895

Dahl, A. J., Peltier, J. W., & Schibrowsky, J. A. (2018). Critical thinking and reflective learning in the marketing education literature: A historical perspective and future research needs. *Journal of Marketing Education, 40*(2), 101-116. https://doi.org/10.1177/0273475317752452

Dilekli, Y., & Tezci, E. (2020). A cross-cultural study: Teachers' self-efficacy beliefs for teaching thinking skills. *Thinking Skills and Creativity, 35*, 100624. https://doi.org/10.1016/j.tsc.2019.100624

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the

21st century. *Thinking Skills and Creativity, 12*, 43–52. https://doi.org/10.1016/j.tsc.2013.12.004

Ekawati, R., Susetyarini, E., Pantiwati, Y., & Husamah, H. (2016). Improving learning outcomes and critical thinking skills with cooperative learning models integrated reading and composition (circ). *JPBI (Jurnal Pendidikan Biologi Indonesia), 1*(3). https://doi.org/10.22219/jpbi.v1i3.2662

Erikson, M. G., & Erikson, M. (2018). Learning outcomes and critical thinking–good intentions in conflict. *Studies in Higher Education, 44*(12), 2293-2303. https://doi.org/10.1080/03075079.2018.1486813

Espey, M. (2017). Enhancing critical thinking using team-based learning. *Higher Education Research & Development*, *37*(1), 15–29. https://doi.org/10.1080/07294360.2017.1344196

Facione, P. A. (2011). *Think critically*. Pearson Education: Englewood Cliffs, NJ.

Facione, P. A. (1999). The disposition toward critical thinking: its character, measurement, and relation to critical thinking skill. *Informal Logic*, 20(1), 61-84. https://doi.org/10.22329/il.v20i1.2254

Fauzi, A. (2019). Profile of junior high school students' critical thinking skills in answering questions related to biological concepts. Scientiae Educatia: *Jurnal Pendidikan Sains*, *8*(1), 51-63. https://doi.org/10.24235/sc.educatia.v8i1.4081

Gupta, M., & Ahuja, J. (2014). Cooperative integrated reading composition (circ): impact on reading comprehension achievement in english among seventh graders. Impact: *International Journal of Research in Humanities, Arts and Literature*, *2*(5), 37-46. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.681.895&rep=rep1&type=pdf

Hadi, S. A., Susantini, E., & Agustini, R. (2018). Training of students' critical thinking skills through the implementation of a modified free inquiry model. *Journal of Physics: Conference Series, 947*(1), 012063. https://doi.org/10.1088/1742-6596/947/1/012063

Irwan, I., Maridi, M., & Dwiastuti, S. (2019). Developing guided inquiry-based ecosystem module to improve students' critical thinking skills. *JPBI (Jurnal Pendidikan Biologi Indonesia), 5*(1), 51-60. https://doi.org/10.22219/jpbi.v5i1.7287

Jarmita, N. (2012). Application of cooperative learning type stad in improving students' mathematical understanding of the subject of building space. *Jurnal Ilmiah DIDAKTIKA*, *13*(1), 150-172. Retrieved from https://jurnal.ar-raniry.ac.id/index.php/didaktika/article/view/470/379

Karakoç, M. (2016). The significance of critical thinking ability in terms of education. *International Journal of Humanities and Social Science*, *6*(7), 81-84. Retrieved from http://www.ijhssnet.com/journals/Vol_6_No_7_July_2016/10.pdf

Komala, R., Suryanda, A., & Lismana, D. D. (2016). The development of paludarium as a medium for learning biology in the subject of ecosystems in high school. Biosfer: Jurnal Pendidikan Biologi, 9(1), 10-14. https://doi.org/10.21009/biosferjpb.9-1.2

Ku, K.Y.L. (2009). Assessing students' critical thinking performance: Urging for measurements using multi-response format. *Thinking Skills and Creativity, 4*(1), 70–76. https://doi.org/10.1016/j.tsc.2009.02.001

Mabruroh, F., & Suhandi, A. (2017). Construction of critical thinking skills test instrument related the concept on sound wave. *Journal of Physics: Conference Series, 812*(1), 012056. https://doi.org/10.1088/1742-6596/812/1/012056

Masitoh, I. D., Marjono, M., & Ariyanto, J. (2017). The influence of guided inquiry learning model on the critical thinking ability of class x mia students on environmental pollution material in Surakarta. *Bioedukasi*, *10*(1), 71-79. http://dx.doi.org/10.20961/bioedukasi-uns.v10i1.11276

Megamaya, M., Putra, A., & Zulaikha, S. (2014). The effect of the circ learning model assisted by audio visual media on the reading skills of Indonesian language lessons for elementary school students in Tampaksiring. *e-Journal Mimbar PGSD Universitas Pendidikan Ganesha Jurusan PGSD*, *2*(1), 1-10. http://dx.doi.org/10.23887/jjpgsd.v2i1.1890

Miharja, F. J., Hindun, I., & Fauzi, A. (2019). Critical thinking, metacognitive skills, and cognitive learning outcomes: a correlation study in genetic studies. *Biosfer: Jurnal Pendidikan Biologi, 12*(2), 135-143. https://doi.org/10.21009/biosferjpb.v12n2.135-143

Mulyana, S., Rusdi., & Sigit, D. V. (2018). The effect of guided inquiry learning model and scientific performance on student learning outcomes. *Indonesian Journal of Science and Education*, *2*(1), 105-109. https://doi.org/10.31002/ijose.v2i1.596

Musyaddad, A., & Suyanto, S. (2019). Evoking the four dimensions of student knowledge in ecosystem: effectiveness of real object, web, and blended learning. *Biosfer: Jurnal Pendidikan Biologi, 12*(2), 194-210. https://doi.org/10.21009/biosferjpb.v12n2.194-210

Noviyanti, E., Rusdi, R., & Ristanto, R. H. (2019). Guided discovery learning based on internet and self concept: enhancing student's critical thinking in biology. *Indonesian Journal of Biology Education, 2*(1), 7-14. https://doi.org/10.31002/ijobe.v2i1.1196

Osman, K., Hiong, L. C., & Vebrianto, R. (2013). 21st century biology: An interdisciplinary approach of biology, technology, engineering and mathematics education. *Procedia-Social and Behavioral Sciences, 102, 188-194*. https://doi.org/10.1016/j.sbspro.2013.10.732

Paul, R., & Elder, L. (2001). *The miniature guide to critical thinking: Concepts & tools*. Foundation Critical Thinking. Retrieved from https://www.criticalthinking.org/files/Concepts_Tools.pdf

Permana, T. I., Hindun, I., Rofi'ah, N. L., & Azizah, A. S. N. (2019). Critical thinking skills: Its correlation with academic ability, mastering concepts, and analytical skill of undergraduate students in botany class. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *5*(1), 1-8. https://doi.org/10.22219/jpbi.v5i1.7626

Probosari, R. M. (2015). Improvement of students' scientific writing of biology education of sebelas maret university through reading project-based learning. *Indonesian Journal of Science Education*, *4*(1), 31-35. https://doi.org/10.15294/jpii.v4i1.3498

Rabgay, T. (2018). The effect of using cooperative learning method on tenth grade students' learning achievement and attitude towards biology. *International Journal of Instruction*, *11*(2), 265-280. https://doi.org/10.12973/iji.2018.11218a

Ristanto, R.H., Zubaidah, S., Amin, M., & Rohman, F. (2017). Scientific literacy of students learned through guided inquiry. *International Journal of Research and Review, 4*(5), 23-30. Retrieved from https://www.ijrrjournal.com/IJRR_Vol.4_Issue.5_May2017/IJRR004.pdf

Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F. (2018a). From a reader to a scientist: developing cirgi learning to empower scientific literacy and mastery of biology concept. *Biosfer: Jurnal Pendidikan Biologi*, *11*(2), 90-100.

https://doi.org/10.21009/biosferjpb.v11n2.90-100

Ristanto, R.H., Zubaidah, S., Amin, M., & Rohman, F. (2018b). The potential of cooperative integrated reading and composition in biology learning at higher education. *International Journal of Educational Research Review, 3*(1), 50-56. https://doi.org/10.24331/ijere.376727

Ristanto, R. H., Djamahar, R., Heryanti, E., & Ichsan, I. Z. (2020). Enhancing students' biology-critical thinking skill through circ-based scientific approach (cirsa). *Universal Journal of Educational Research, 8*(4A), 1-8. https://doi.org/10.13189/ujer.2020.081801

Robertson, W.C. (2013). *Jawaban untuk pertanyaan sains*. Jakarta: Indeks.

Septiana, D., Miarsyah, M., & Komala, R. (2017). The effect of reciprocal teaching learning model integrated mind map and persistence on student retention of kingdom animalia concept. *Biosfer: Jurnal Pendidikan Biologi*, *10*(2), 35-41. https://doi.org/10.21009/biosferjpb.10-2.5

Siregar, R.A., Festiyed, F., Marsidin, S., & Ellizar, E. (2019). The practice of animation assisted inquiry learning model in senior high school chemistry learning. *Advances in Social Science, Education and Humanities Research*, 178, 585-590. https://doi.org/10.2991/icoie-18.2019.124

Slavin, R. E. (2005). *Cooperatif Learning Theory Research and Practice Second Editions*. USA: A Simon & Schoter Company.

Sugiyono. (2012). *Metode penelitian kuantitatif kualitatif dan r&d*. Bandung: Alfabeta.

Suyamto, J., Masykuri, M., & Sarwanto. (2018). An analysis of the initial profile of students` critical thinking skills in learning circulator system at xi grader of sma n 1 gondang sragen. *Advances in Social Science, Education and Humanities Research,* 267, 53-57. Retrieved from https://download.atlantis-press.com/article/55908976.pdf

Teo, P. (2019). Teaching for the 21st century: A case for dialogic pedagogy. *Learning, Culture and Social Interaction, 21*, 170–178. https://doi.org/10.1016/j.lcsi.2019.03.009

Tishman, S., Jay, E., & Perkins, P. N. (1993). Teaching thinking dispositions: From transmission to enculturation. *Theory into Practice*, *32*(3), 147-153. http://dx.doi.org/10.1080/00405849309543590

Tofade, T., Elsner, J., & Haines, S. T. (2013). Best practice strategies for effective use of questions as a teaching tool. *American Journal of Pharmaceutical Education*, *77*(7), 1–9. https://doi.org/10.5688/ ajpe777155

Torkar, G., & Krašovec, U. (2019). Students' attitudes toward forest ecosystem services, knowledge about ecology, and direct experience with forests. *Ecosystem Services, 37, 100916.* https://doi.org/10.1016/j.ecoser.2019.100916

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco, CA, US: Jossey-Bass. Retrieved from https://psycnet.apa.org/record/2009-18745-000.

Vanicheva, T., Kah, M., & Ponidelko, L. (2015). Critical thinking within the current framework of ESP curriculum in technical universities of Russia. *Procedia-social and behavioral sciences, 199*, 657-65. https://doi.org/10.1016/j.sbspro.2015.07.595

Wartono, W., Hudha, M. N., & Batlolona, J. R. (2017). How are the physics critical thinking skills of the students taught by using inquiry-discovery through empirical and theorethical overview?. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(2), 691-697. https://doi.org/10.12973/ejmste/80632

Widana, I. W., Parwata, I. M. Y., Parmithi, N. N., Jayantika, I. G. A. T., Sukendra, K., & Sumandya, I. W. (2018). Higher order thinking skills assessment towards critical thinking on mathematics lesson. *International Journal of Social Sciences and Humanities*, *2*(1), 24-32. https://doi.org/10.29332/ijssh.v2n1.74

Yamane, T. (1967). *Statistics: An Introductory Analysis, 2nd Editio*n. New York: Harper and Row.