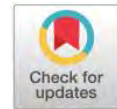


Research Article

Critical and analytical thinking skill in ecology learning: A correlational study



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ABSTRACT

Critical and analytical thinking skills are included in higher-order thinking skills which become the focus of educational goals in recent era. This study aimed to determine the relationship between critical and analytical thinking skills in ecology learning at senior high school in East Jakarta. This research was conducted from March to June 2020. The research method used was descriptive correlational with associative research. This study involved 180 students. As many as 52 students were selected as research participants using cluster random sampling. The data were collected using a critical and analysis thinking rubric which was integrated to essay questions. The data analysis technique used was simple linear regression. The results indicates that there is **significant correlation between students' critical and analytical thinking skill** ($r = 0.812$, $r^2 = 0.659$, $N = 52$). In addition, **students' analytical thinking skill** could be predicted using the regression equation $y = 5.41 + 0.91x$ which means that it gives a positive effect to **students' critical thinking skills**. The contribution of critical thinking skills with analytical thinking skills was 65.9%.



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INTRODUCTION

Currently, higher-order thinking skills have become the focus of educational goals in various parts of the world in recent periods (Kusuma et al., 2017; Madhuri et al., 2012; Vidergor, 2018; Yeung, 2015). Critical thinking skills are one of these skills (Barnett & Francis, 2012; Saputri et al., 2019; Susilawati et al., 2020). Critical thinking skill is an active process and a way of thinking regularly to understand the information in-depth. By using these skills, students are encouraged to find the truth of the information obtained. According to Ghazivakili et al. (2014) critical thinking includes mental activities in terms of solving problems, analyzing assumptions, providing a rationale, evaluating, conducting investigations, and making decisions. Critical thinking skills must be developed because they are not innate and do not develop naturally (Guleker, 2015; Maryuningsih et al., 2019; Toy & Ok, 2012). These skills can be developed by getting used to activities that encourage students to think. Thinking critically in the learning process is very important to train students' critical thinking (Changwong et al., 2018; Karakoç, 2016).

The skill to think critically is one of the higher-order thinking skills (Barnett & Francis, 2012; Ghanizadeh, 2017), as well as analytical thinking skills (Bairagya & Joy, 2021; Kurniati et al., 2016; Permana et al., 2019). These two skills are higher-order thinking skills that students in the 21st-century need to have. Both can be developed in student learning activities that can provide meaningful experiences to accommodate these two skills. As reported by Birgili (2015) students must be able to solve problems in learning with the results of their critical thoughts. This ability will be supported by the skills to analyze the information and data used to find solutions to these problems (Permana et al., 2019; Wilkin, 2017). Thus, analytical thinking skills strongly support analytical thinking skills. This means that the indicator of analytical thinking skills is an important indicator in developing critical thinking skills.

Critical thinking skills and analytical skills are important to be developed in the learning process. It is known that in the 21st-century students are expected to be able to solve problems critically with analytical skill by considering various things related to logical or logical reasons and to offer innovations (Belecina & Ocampo, 2018). Analyzing is an activity in the form of breaking down material into its parts and determining how the parts are connected between parts to create a concept (Bairagya & Joy, 2021; Wendt & Åse, 2015). Someone who can think analytically will have the ability to research and describe the facts of a problem. They can think wisely and smartly in solving problems by analyzing, remembering, and using information (Belecina & Ocampo, 2018; Ricco et al., 2020). Critical thinking is a process that must involve analytical skills. Critical thinking skills provide appropriate direction for students to solve problems more accurately by linking with various relevant concepts (Belecina & Ocampo, 2018). Furthermore, with analytical thinking skills, students can find relationships between various concepts or information and be able to describe them well (Ghazivakili et al., 2014; Permana et al., 2019).

However, the two high-order thinking skills are still low among Indonesian students (Kusuma et al., 2017; Ramdiah & Duran Corebima, 2014; Santosa, 2012; Saputri et al., 2019; Suarniati et al., 2018). The contributing factor is that students are not trained enough to have higher-order thinking skills (Hanifah, 2019; Ramdiah et al., 2019; Ramdiah & Duran Corebima, 2014). Students do not get the opportunity to empower these skills in their learning because of the weak learning model used. Learning models that can have an impact on students' critical thinking and analysis skills are problem-based (Birgili, 2015; Karantzas et al., 2013; McCrum, 2017; Siew & Mapeala, 2016; Suarniati et al., 2018; Zabit, 2010). Problem-based learning can be applied to materials specifically relevant, such as ecology learning.

In ecology learning, students study the interactions between living things and other living things and also with the surrounding environment. Ecology is used as a basic science for understanding interactions in the environment. By studying the concept of ecology, it is hoped that humans can create a sustainable living environment without causing environmental problems, such as floods, red tides, etc. In ecology learning, students can also learn how to deal with problems that arise in the environment. In the learning process of ecology material, students are expected to be able to critically analyze information or data from various sources about ecosystems and all the interactions that occur in them. Therefore, ecology learning can direct students to have the ability to think critically in solving problems and be able to analyze phenomena that occur in the environment with their ecological concepts. Thus, in ecology learning, students can train and develop these two high-order thinking skills so that later they can solve and connect the concepts they have learned.

In connection with the importance of higher-order thinking skills in learning in schools, various researchers have researched this matter. Several studies have looked at the relationship between critical thinking skills with student creativity (Rusyana, 2017; Usman et al., 2020), logical thinking (Rusyana, 2017), analytical thinking (Permana et al., 2019) in general biology material. However, the relationship between critical and analytical thinking skills in ecology learning has not been carried out. Therefore, the purpose of this study was to determine the relationship between critical thinking skills and analytical thinking skills in ecology learning. This research is expected to contribute to improving the education and learning system so that students have higher-order thinking skills.

METHOD

This descriptive correlational study was associative research. This research method was used by researchers to assess and see the correlation between critical and analytical thinking skills. The variables in this study consisted of one predictor variable (critical thinking skill) and one criterion variable (analytical thinking skill). The research subjects were tenth graders of senior high school in Jakarta in the 2019/2020 academic year with the number 180 students (from 5 class). While the research samples were 52 students who were selected using the cluster random sampling technique. The material used in the research was related to ecology.

The data was measured by using the students' worksheets which comprise eight questions to measure critical thinking skills and six questions to measure analytical thinking skills. The questions were included in cognitive levels C4, C5, and C6. The research instrument was arranged based on indicators of critical thinking skills and indicators of analytical thinking skills (Table 1).

Table 1. Indicators of critical and analytical thinking skill

Skill measured	Indicators
1. Critical thinking skills	Providing a simple explanation Building basic skills Inference Providing a further explanation Strategy and tactics
2. Analytical thinking skills	Distinguishing Organizing Connecting

The instrument was tested first to determine its validity and reliability. The data was analyzed used the Product Moment Correlation technique performed by Pearson to determine the validity of the questions and Cronbach's alpha test to determine the reliability of the questions. The results of the analysis of the question items there were 8 out of 10 items of valid critical thinking skills questions with a reliability value is 0.66 (reliable category). While, for the analytical thinking skills questions, all the items were valid with a reliability value is 0.62 (reliable category). The data correlation between students' critical and analytical thinking skills was analyzed using simple linear regression, correlation test, and normality test. Then the hypothesis was tested using the r-test. The data analysis was calculated using Microsoft Excel software.

RESULTS AND DISCUSSION

Based on the research results, the average of students' critical thinking skills obtained is 68.15 with a standard deviation of 9.1. While the average of students' analytical thinking skills obtained is 67.15 with a standard deviation of 10.94. The highest score for students' critical thinking skills was 90.63 and the lowest score was 46.88. Meanwhile, the highest score of students' analytical thinking skills was 91.67, while the lowest score was 45.83. The percentage for each indicator of students' critical thinking skills is presented in Table 2. The data explains that the highest percentage of critical thinking skill indicator is building basic skill (80.77%) which is considered as good. While the lowest percentage is the strategy and tactics indicator (59.62%) which is classified as good enough. Then the other three indicators (providing a simple explanation, inference, providing a further explanation) are classified as good.

Table 2. Percentage of critical thinking skill indicators

Indicators	Percentage
Providing a simple explanation	72,60%
Building basic skills	80,77%
Inference	67,79%
Providing a further explanation	62,02%
Strategy and tactics	59,62%

Table 3 shows the results of the analytical thinking skill indicator. The result showed that the highest percentage of analytical thinking skill indicator is organizing skill (69.47%), while the lowest is distinguishing skill (65.14%). Both results of the two skills measured show that the data is normally distributed. The results of the normality test for the value of critical thinking skills and analytical thinking skills were both more than 0.05, namely 0.23 and 0.19, respectively.

Table 3. Percentage of analytical thinking skill indicators

Indicators	Percentage
Distinguishing	65,14%
Organizing	69,47%
Connecting	66,83%

The results indicate that the average of the two variables is classified into good criteria (between 61-80). The average score of critical thinking skills is 68.15, while the analytical thinking skill is 67.15. It means that the students have developed critical and analytical thinking skills. It is because of the influence of the

students' academic backgrounds in science class that make it a habit to practice their higher-order thinking skills (Kim & Pegg, 2019; Tindangen, 2018; Wartono et al., 2018). This is by the opinion Nisa et al. (2018) that higher-order thinking skills are caused by learning in science classes which invite students to take an active role in problem-solving activities. Especially in ecology learning, which directs students to give their ideas in the process of solving environmental critical issues to practice higher-order thinking skills.

The second factor is the use of assessment based on higher-order thinking skills questions (Barnett & Francis, 2012; Kusuma et al., 2017). These questions were developed to measure the achievement of basic competencies. Students who are accustomed to solving higher-order thinking questions will more often hone their critical and analytical thinking skills. The next factor is the high students' motivation to learn. This motivation comes from their self, teacher, family, friends, and their learning environment. This is in line with the theory that the acquisition of good higher-order thinking skills is due to high learning motivation (Blašková, 2014; Permana et al., 2019; Suratno et al., 2020). The other factor is the use of an effective learning model in improving students' higher-order thinking, especially their critical thinking and analytical thinking skills. The results of the observation show that the teachers in the research subject schools applied problem-based learners several times. Problem-based learning is known to provide experience for students to empower their critical and analytical thinking skills (Cargas et al., 2017; Lewinsohn et al., 2014; Nargundkar et al., 2014; Ulger, 2018).

The findings of this study are also supported by Dafrita (2017) who states that students' critical thinking and analysis skills will both improve if the learning process provides good experiences for students such as discovery learning. Critical students are students who are capable of analyzing their arguments, educating and assessing the results of education, and identifying their assumptions (Firdaus et al., 2015; Mayweg-Paus et al., 2016; Schoenberger-Orgad & Spiller, 2014; Suarniati et al., 2018). However, the results showed that the lowest critical thinking skills indicator was formulating strategies and tactics with a percentage of 59.62% (Table 2). This is because students still have mistaken in determining strategic and tactical steps in understanding each problem. This can happen when students do not focus on solving problems. As stated (Amalia & Hadi, 2020) there are many mistakes experienced by students in Indonesia in understanding answering the questions given.

Furthermore, the results of the simple linear regression test for critical thinking skills with analytical thinking skills show that the acquisition of A value is 5.41 and B value is 0.91. The determining regression equation is using the formula $y = A + Bx$. Thus, the regression equation of students' critical and analytical thinking skills is $y = 5.41 + 0.91x$. Thus, it shows a positive influence between critical thinking skills and analytical thinking skills, because the regression coefficient (Bx) has no negative sign in front of the number. The regression linearity testing criteria is if $F_{tc} < F_{kk}$ then the regression of the two variables is linear. The result showed that the linearity result of F_{tc} value is 0.96 and F_{kk} is 4.03 with a significance level (α) = 0.05. It can be seen that $F_{tc} > F_{kk}$, it can conclude that the two skills in this study can form a linear line. The simple linear regression test is supported by the graph in Figure 1.

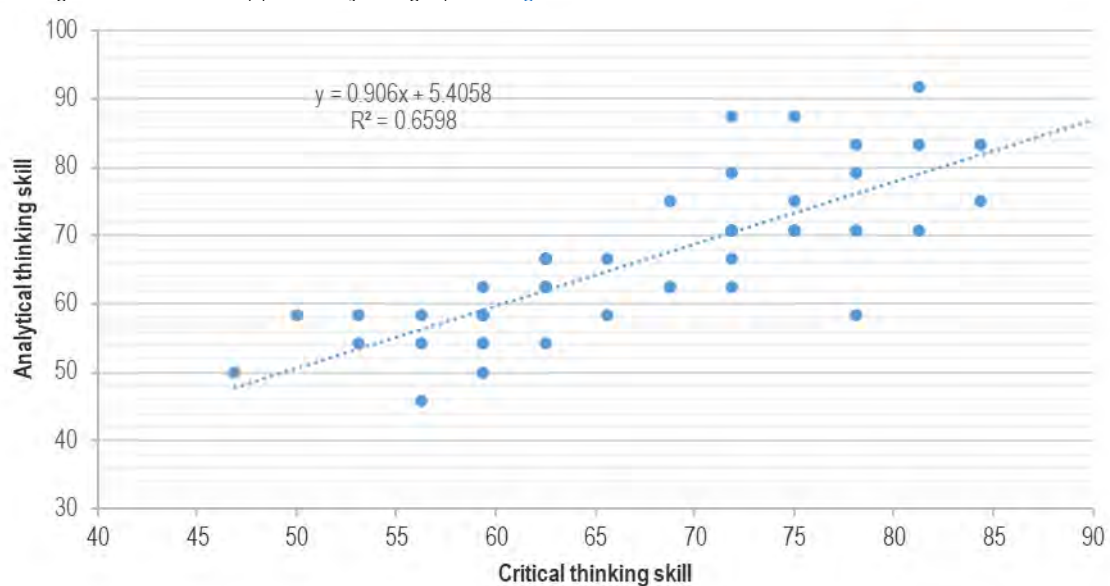


Figure 1. Graph of the linear regression of students' critical and analytical thinking skills

Furthermore, a correlation test was carried out to determine the correlation between the two skills (Table 4). The results show that the r-value is 0.812, and for the r table value with a significance level of 5%, it is

0.279, so it can be stated that the $r > r_{table}$. Thus, it can be concluded that there is a very strong relationship between critical thinking skills and analytical thinking skills. The contribution of critical thinking skills to analytical thinking skills is 0.659. This means that critical thinking skills can predict analytical thinking skills by 65.9%, while 34.1% is influenced by other variables.

Table 4. Correlation Test of the Correlation of Critical Thinking Ability with Analysis

Thinking skill	r	r_{table}	R^2 (R square)
Critical and analytical thinking skill	0,812	0,279	0,659

Students' critical thinking skills contributed significantly to their analytical thinking skills (65.9%). It is known that the indicators of analytical skills are also related to indicators of critical thinking skills. In line with the statement (Bensley & Spero, 2014), analytical thinking is part of critical thinking skills. This is because critical thinking skills involve a process of analysis, synthesis, and evaluation of a concept (Karantzas et al., 2013; Wilkin, 2017). When students empower critical thinking skills, they automatically cultivate their skills in analyzing a phenomenon or problem (Birgili, 2015; Permana et al., 2019). Students analyze the arguments and information obtained then judge their correctness. This is an indicator of analytical skills. Furthermore, students formulate decisions or problem-solving based on the results of the thinking process. Another study states that students' analytical thinking skills have a major contribution to students' critical thinking skills (Permana et al., 2019). Thus the selection of the right learning model, such as a problem-based learning (Birgili, 2015; Nargundkar et al., 2014; Rajagukguk & Simanjuntak, 2015; Ulger, 2018), discovery learning (Saputri et al., 2019; Wartono et al., 2018), inquiry (Madhuri et al., 2012; Pedrosa-de-Jesus et al., 2014; Tindangen, 2018; Zohar & Alboher Agmon, 2018), can contribute to higher-order critical thinking, especially critical and analytical thinking skills because they are both positively correlated. Both of these skills are very important for students to have to face the challenges in this 21st-century. The existence of this research is expected that educators will continue to train students' higher-order thinking skills so that they can develop over time.

CONCLUSION

The research finding concluded that there is a significant correlation between students' critical thinking skills and analytical thinking skills. The students' critical thinking skill has positive correlation toward their analytical thinking skills with contribution is 65.9%. The regression equation is $y = 5.41 + 0.91x$. The student's critical thinking skills can be used to predict the students' analytical thinking skills. Through the finding, both skills are expected to help students solve the problems they face, and help them to make wise decisions with logical thinking. For further research, it is hoped that implementation of learning model which hones these skills must be done. So that both skills are continuously trained and help students deal with the problems around them.

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