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The Correlation Between Critical and Creative Thinking Skills on Cognitive Learning Results

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ABSTRACT

Purpose: A correlational research was conducted to reveal the correlation between critical thinking and creative thinking skills on students' cognitive learning results in inquiry learning strategy and to reveal the contribution of critical thinking skills and creative thinking skills to students' cognitive learning results. **Method:** The population of this research was students of Biology Education Study Program in the Education and Teacher Training Faculty of Jambi University, Indonesia in the semester of 2017/2018 academic year. The instrument used was an essay test to measure students' critical and creative thinking skills, and their cognitive learning results. The data were analyzed using multiple regression analysis with the assistance of SPSS version 16 for Windows program at 5% level.

Findings: The results showed that: (1) there was a significant correlation between critical thinking skills and creative thinking skills on cognitive learning results, (2) the contribution of critical thinking skills and creative thinking skills simultaneously to cognitive learning results was 72.80%, (3) the effective contribution of creative and critical thinking skills to cognitive learning results was 64.91% and 7.89% respectively.

Implications for Research and Practice: Lecturers can consider inquiry strategies as an alternative learning, especially for new students in universities to empower critical thinking skills and creative thinking skills, based on research results, that may have a big contribution to cognitive learning results.

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Introduction

The need for the 21st century in the curriculum of educational institutions is oriented to create productive, creative, innovative, and effective generations through the integration of attitudes, abilities and knowledge with life skills (Andrini, 2016; Kabeel and Eisa, 2016; Taghva, Rezael, Ghaderi, and Taghva, 2014). Higher education institutions have made various efforts to improve their quality, in order to produce professional students, because critical thinking education is a process that involves all levels of education (Unlu, 2018). Learning is effective when the learning strategy implemented bring about desired changes in students' behavior (Oghenevwede, 2010). The results of a meaningful learning will likely to be meaningful, both in the cognitive, effective, and psychomotor aspects (Corebima, 2006). One of the learning strategies that can create meaningful learning is the inquiry strategy.

Inquiry learning strategy gives opportunities for students to learn concepts, to develop investigation skills, and to gain understanding of science concepts (Bybee, 2002). According to Llewellyn (2013), the implementation of inquiry learning can explore and empower thinking skills. Inquiry strategy fosters a positive science attitude (Harlen, 2014) and triggers students' cognition (Breivik, 2016). The application of inquiry strategy has a significant effect on students' learning results (Llewellyn, 2013; Njoroge, Changeiywo, and Ndirangu, 2014; Olukayode, 2012; Opara, 2011), and it is recommended to be implemented in learning, in order that students are actively involved in the exploration process using logical and critical thinking skills.

Inquiry learning can effectively and significantly develop critical thinking skills (Avsec and Kocijancic, 2014; Azizmalayer, Jafari, Sharif, Asgari, and Omidi, 2012; Duran and Dökme, 2016; Kitot, Ahmad, and Seman, 2010; Smallhorn, Young, Hunter, and Da Silva, 2015); it can also train critical thinking skills (Michalopoulou, 2014; Prince and Felder, 2006; Zubaidah, Fuad, Mahanal, and Suarsini, 2017). Inquiry learning can improve creative thinking skills (Al-Jarf, 2009; Keleş, 2012; Michalopoulou, 2014; Şeyihoğlu and Kartal, 2010; Weinstein, 2014). Llewellyn (2013) recommended the implementation of inquiry learning in order that students were actively involved in the process of exploring and empowering their thinking skills. Thus, the inquiry learning strategy can create more meaningful and effective learning towards critical thinking skills and creative thinking skills.

Critical thinking is the most valuable skill that can be passed on by the school to its graduates and becomes a learning goal at all levels of discipline (Thompson, 2011). The development of critical thinking skills has become the focus of attention in meeting the needs of the labor market with social and complex challenges (Cruz, Payan-Carreira, and Dominguez, 2017). Critical thinking skills are needed by education graduates to solve increasingly complex life problems (Živković, 2016). Critical thinking skills are required to develop students' abilities (Hashemi, 2011); it is a generator to produce ideas and innovations both comparatively and competitively in global competition (Martincová and Lukešová, 2015).

Several research results have revealed the correlation between critical thinking skills and learning results, including the concept gaining. Critical thinking has a significant correlation with learning results, including concept gaining and cognitive ability (Alter, 2009; Chukwuyenum, 2013; Dehghani, Sani, Pakmehr, and Malekzadeh, 2011). Critical thinking has a correlation with high order thinking skills (Page and Mukherjee, 2006) such as analyzing, synthesizing and evaluating.

Another skill that needs to be developed is creative thinking skills. According to Hadzigeorgiou, Fokialis, and Kabouropoulou (2012), creative thinking skills are the foundation of science, which are very important for students (Baker and Rudd, 2001), is a form of expressing oneself in a unique way (Abraham, 2015). Several research results have a positive correlation with cognitive learning results (Lin and Wu, 2016; Nami, Marsooli, and Ashouri, 2014; Vasudevan, 2013; Yusnaeni, Susilo, Corebima, and Zubaidah, 2016). The optimization of thinking skills is very important, because it is a life skill that needs to be developed (Zubaidah, 2010), which is needed to overcome complex problems along with biological development.

The research on the effect of inquiry learning strategy on critical thinking skills, creative thinking skills and learning results has been widely conducted. The information on the correlation and contribution of critical thinking skills and creative thinking skills toward cognitive learning results using inquiry learning strategy has not been revealed. Therefore, it is essential to conduct a research to reveal the correlation between critical thinking skills and creative thinking skills toward cognitive learning results at the implementation of inquiry learning strategy and to find out the amount of the related contribution. Therefore, the research hypothesis is formulated as there is a correlation between critical thinking and creative thinking skills simultaneously toward cognitive learning results at the implementation of inquiry learning strategy. The contribution value is used as a basis of information and recommendations for the application of inquiry strategy to improve the quality of learning.

Method

Research Design

This research was classified into a descriptive-correlational research, using One-Group Pretest-Posttest Design (Arikunto, 2013, p.124; Sugiyono, 2016, p.74). This design included a pretest measure followed by a treatment and a posttest for a single group (Creswell, 2014) as presented in Table 1.

Table 1

The One Group Pretest-Posttest Design

Pretest	*Treatment*	*Posttest*
O_1	X	O_2

O_1 : The pretest score of the experiment class
X : Learning with an inquiry strategy
O_2 : The posttest score of the experiment class

Related to this research design an observation was carried out before the experiment (O1) called the pretest, and an observation was also carried out after the experiment (O2) called the posttest. This research is a correlational research which aims at revealing the correlation between critical thinking and creative thinking skills toward cognitive learning results at the implementation of inquiry learning strategy.

Research Sample

This research was conducted in 2017-2018 academic year. The population of this research was all under graduate students of Biology Education Study Program in Teacher Training and Education Faculty of Jambi University, Indonesia. The participants of this study were 52 undergraduate students consisting of 6 male students and 46 female students in Biology Education who took Environmental Science class.

Research Instruments and Procedures

The research data were obtained from the results of critical thinking skill test, creative thinking test, and cognitive learning result test in the form of pretest and posttest. The research instrument used to measure students' critical thinking skills, creative thinking skills, and cognitive learning results is an essay test, with a total number of 12 questions. The critical thinking skill rubric was adapted from the assessment rubric developed by Zubaidah, Corebima, and Mistianah (2015) with a scale of 0-5. The creative thinking skill test was adapted from Treffinger, Young, Selby, and Shepardson (2002). The data of cognitive learning result test with non-rubric assessment used 5 subscales. The assessment score obtained was converted to a score with a scale of 0-100. The data of critical thinking skills and creative thinking skills were used as the predictor variables, and the score of cognitive learning results was used as the criterion variable.

Validity and Reliability

The validity and reliability of the test instrument was obtained through a try out, conducted on 22 biology education students in the fourth semester of the 2017/2018 academic year who had passed the same course. The recapitulation of the instrument test item analysis based on the results of the try-out was analyzed with the assistance of Anates Ver. 4.0 because it was relatively easy to be used (Arif, 2014). The results showed that the XY correlation was 0.72, and the reliability test was 0.83. Thus, it could be concluded that all the instruments were valid (Widoyoko, 2014, p.180). The results of the reliability index of the test instrument showed that the Statistics Reliability score (Cronbach's Alpha) was 0.83, so it could be concluded that the instrument was reliable (Widoyoko, 2014, p.180).

Data Analysis

The research data were analyzed using multiple regression analysis to reveal the correlation between critical thinking skills and creative thinking skills toward students' cognitive learning results. The research data analyzed were the corrected data. Before the hypothesis testing was performed, a normality test and a

homogeneity test were initially done. The data were analyzed with the assistance of SPSS version 16.0 for windows at a significance level of 5%.

Results

Based on the results of the data normality test, the sig. values of critical thinking skills, creative thinking skills, and cognitive learning results were 0.789, 0.816 and 0.957 respectively. Thus, it can be concluded that the data were normally distributed. Based on the results of homogeneity test, the sig. values of critical thinking skills, creative thinking skills, and cognitive learning results were 0.554, 0.641 and 0.901 respectively. It can be concluded that the data were homogeneous. The results of the analysis on the correlation between critical thinking and creative thinking skills toward cognitive learning results at the implementation of inquiry learning strategy are presented in Table 2.

Table 2

Summary of Anova on The Correlation between Critical Thinking and Creative Thinking Skillstoward Cognitive Learning Results

Model		*SS*	*df*	*MS*	*F*	*Sig.*
1	Regression	1102.589	2	551.295	65.440	.000[a]
	Residual	412.799	49	8.424		
	Total	1515.388	51			

a. Predictors: (Constant), Creative Cor., Critical Cor.
b. Dependent Variable: Cognitive Cor.
SS: Some of Squares, *df*: Degrees of freedom, *MS*: Mean Square

Table 2 shows that the p value = 0.000 meaning that critical thinking and creative thinking skills have a strong correlation with cognitive learning results at the implementation of inquiry learning strategy.The regression coefficient of the correlation between critical thinking skills and creative thinking skills toward cognitive learning results at the implementation of inquiry learning strategy is presented in Table 3.

Table 3

Regression Coefficients of The Correlation between Critical Thinking Skill and Creative Thinking Skill toward Students' Cognitive Learning Results

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	Std.Error	Beta		
1	(Constant)	15.261	3.251		4.694	.000
	Critical Thinking Cor	.139	.114	.123	1.218	.229
	Creative Thinking Cor	.733	.097	.765	7.550	.000

a. Dependent Variable: Cognitive Cor

The results of the multiple linear regression test (Table 3) found that the regression equation is $Y= 0,139X_1 + 0,733X_2 + 15,261$. The amount of the contribution of critical thinking skills and creative thinking skills toward cognitive learning results is presented in Table 4.

Table 4

The Summary of The Regression of The Correlation between Critical Thinking Skills and Creative Thinking Skillstoward Students' Cognitive Learning Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.853[a]	.728	.716	2.903

a. Predictors: (Constant), Creative Cor, Critical Cor
b. Dependent Variable: Cognitive Cor

The results of the multiple regression analysis show that the regression coefficient value (R) is 0.853 and the determination coefficient is (R^2) 0.728. This means that the contribution of critical thinking skill and creative thinking skill toward cognitive learning result is 72.80%, while the remaining as much as 27.20% is influenced by other variables. The amount of relative and effective contribution of the independent variables (predictors), toward the dependent variable (criterion), namely the cognitive learning results, is presented in Table 5.

Table 5

Contribution of Critical Thinking Skills and Creative Thinking Skillstoward Students' Cognitive Learning Results

Variable	RC (%)	EC (%)
X1 (Critical Thinking Skills)	10.84	7,89
X2 (Creative Thinking Skills)	89.16	64,91
Total	100	72,80

Description: RC = Relative Contribution; EC = Effective Contribution.

Table 5 shows that the relative contribution of critical thinking skills toward cognitive learning results is 10.84%, and the relative contribution of creative thinking skills toward cognitive learning results is 89.16%. The effective contribution of critical thinking skills toward cognitive learning results is 7.89%, and the effective contribution of creative thinking skills toward cognitive learning results is 64.91%. Thus, the total effective contribution is 72.80%. Therefore, it can be concluded that creative thinking skill has a bigger contribution toward cognitive learning results than the critical thinking skill does.

Discussion, Conclusion and Recommendations

The results of multiple linear regression analysis revealed that critical thinking skills and creative thinking skills can effectively improve cognitive learning results. This shows that there is a very strong correlation between critical thinking skills and

creative thinking skills toward cognitive learning results. The contribution of the critical thinking skills and creative thinking skills was 72.80%, and the remaining 27.20% was influenced by other variables not examined in the this research. The implementation of inquiry learning is proven having potential to give a significant contribution to critical thinking skills and creative thinking skills which eventually can improve cognitive learning outcomes.

The results of this research are in accordance with the research results by Alghafri and Bin Ismail (2014), reporting that there was a significant correlation between critical thinking and creative thinking skills toward cognitive learning results at the implementation of inquiry strategy. Inquiry learning is significantly effective in developing critical thinking skills (Avsec and Kocijancic, 2014; Duran and Dökme, 2016; Kitot et al., 2010; Prince and Felder, 2006; Smallhorn et al., 2015). Inquiry learning can explore and empower students' thinking skills (Llewellyn, 2013). Inquiry learning can train critical thinking skills (Prince and Felder, 2006).

The implementation of inquiry learning can improve creative thinking skills(Al-Jarf, 2009; Keleş, 2012; Michalopoulou, 2014; Seyihoğlu and Kartal, 2010; Weinstein, 2014). Llewellyn (2013) recommended the implementation of inquiry learning in learning, so that students are actively involved in the process of exploring and empowering their thinking skills. Inquiry learning can train students' creative thinking skills (Michalopoulou, 2014; Zubaidah et al., 2017). Inquiry-based learning is more effective for science learning (Crawford, 2007; Hmelo-Silver, Duncan, and Chinn, 2007; Minner, Levy, and Century, 2010). These statements proved that inquiry learning strategy is a meaningful and effective learning strategy. Inquiry strategy can also improve social activities, life culture and communication. Strength category in higher education strategies includes social activities, life culture, and communication (Cevher and Yuksel, 2015).

The implementation of inquiry strategy has a significant effect on learning results, learning achievement including students' concept gaining (Llewellyn, 2013; Njoroge et al., 2014; Olukayode, 2012; Opara, 2011). Students' learning achievement can be reflected in the process and cognitive dimensions of students (Krathwohl, 2002). Inquiry learning provides opportunities for students to develop their understanding and abilities (Bybee, 2002), to increase motivation and interest in the topic (Sadeh and Zion, 2012). The discussion in the inquiry strategy also raises cognitive conflict (Barrouillet, 2015). In this activity, students' discussion is based on the data collected to develop conceptual knowledge (Minner, Levy, and Century, 2010).

Based on the potential contribution in improving students' learning results in this research, it was found that the critical thinking skills have a smaller contribution than that of the creative thinking skills. This means that the contribution of the critical thinking skills as a predictor variable is less strong. This result is in line with the research results byAktaş and Ünlü (2013), Alghafri and Bin Ismail (2014), Birgili (2015), Taghva et al. (2014), stating that there was a moderate correlation, between critical thinking skills and students' learning achievement. This is supported byLujan and DiCarlo (2006) who recommended that teachers needed to focus more on active

learning, more specifically, as a solution for solving the low level of critical thinking skills. The development of critical thinking skills is needed because it provides a positive contribution toward students' learning results (Marzano, et al., 1988).

The effective contribution of critical thinking skills toward cognitive learning results is only 7.89%. At the beginning of this research, the students appeared to have difficulties and were not accustomed with empowering their critical thinking skills. This illustrates that the empowerment of critical thinking skills is also influenced by other factors such as habits and training. Critical thinking skills have a correlation with high-order thinking skills, such as analyzing, synthesizing and evaluating (Page and Mukherjee, 2006). In addition, the research results by Fuad, Zubaidah, Mahanal, and Suarsini (2017) reported that there were differences in critical thinking skills in relation with different learning models.

Students' critical thinking skills need to be optimized (Thompson, 2011). Developing thinking skills is the key to educational success (Alrubaie and Daniel, 2014); critical thinking skills can be developed through phenomenon observation training (Rabu, Aris and Tasir, 2013). These things apparently have been integrated in the syntax of the inquiry strategy (Llewellyn, 2013). Developing critical thinking skills can be done through the activities, such as organizing research, observing, formulating problems and solving problems, asking and answering questions, recording observations and making conclusions, as well as using scientific language (Vieira, Tenreiro-Vieira and Martins, 2011).

At the beginning of this research, students experienced difficulties in planning an inquiry-based activity. The students were accustomed with the learning type such as listening to explanations, and taking notes on lectures. According to Massa (2014), critical thinking skills are mental processes and strategies for analyzing and evaluating ideas, choices, and concepts to make decisions. This can be trained through the implementation of learning strategies. Inquiry strategy trains students to search evidence to make, revise and develop explanations based on the evidence which is found through critical and logical thinking. Finally, the learning process stimulates students to always empower their critical thinking. Through the training process, students develop as scientific observers that support their reasoning (Eberbach and Crowley, 2009). The training in the learning can finally result in contributing students' critical thinking (Prince and Felder, 2006) and contributing to students' cognitive learning results.

In this research, creative thinking variable also had a significant correlation with cognitive learning results, and it had bigger contribution than the critical thinking variable. This is in line with the research results by Lin and Wu (2016), Nami et al. (2014), Vasudevan (2013), Yusnaeni et al. (2016), stating that there was a positive correlation between the creative thinking skills and cognitive learning results. Creative thinking can improve students' academic achievement. Moreover, it can be seen that a change in creativity strategy related to content, process, product, and learning environment will increase students' academic achievement (Altintas and Özdemir, 2015).

Daskolia, Dimos, and Kampylis (2012) stated that creativity, as a theoretical approach, was viewed as a multi-component process, not only involving cognitive aspects but also affective, motivation, and other characteristics. Creative thinking skills can be increased through the implementation of inquiry learning strategy (Al-Jarf, 2009; Keleş, 2012; Michalopoulou, 2014; Seyihoğlu and Kartal, 2010; Weinstein, 2014), and it can also be improved through training (Michalopoulou, 2014; Zubaidah et al., 2017). This can affect the effective contribution toward cognitive learning results, as uncovered in this research. The results of creative thinking skills are different for different learning models (Zubaidah et al., 2017). Developing creative thinking skills is the key to educational success (Alrubaie and Daniel, 2014). Thus, empowering creative thinking skills has concrete benefits to increase students' concept understanding, which can eventually contribute to cognitive learning results.

The amount of the effective contribution of critical thinking skills and creative thinking skills toward cognitive learning results was 72.80%. These results prove that critical thinking skills and creative thinking skills simultaneously have a very significant and effective contribution toward students' cognitive learning results. The better the students' creative thinking skills and critical thinking skills are, the better their cognitive learning outcomes will be. This means that students' critical thinking skills still need to be empowered in learning in order to obtain more optimal results, while maintaining the consistency of students' creative thinking skills. Therefore, students' critical thinking skills and creative thinking skills need to be empowered in learning. Learning which is only oriented to cognitive learning results or scores will not give many benefits for students.

In this research, there was a strong correlation between critical thinking and creative thinking skills in improving students' cognitive learning results. This shows that while the students empower their creative thinking skills in learning, their critical thinking skills will also be involved in it, and vice versa. This is supported by the statement that creative thinking has a correlation with critical thinking (Aizikovitsh-Udi and Amit, 2011; Ülger, 2016). Critical thinking skills and creative thinking skills are integrated in learning (Chang, Li, Chen, and Chiu, 2015) and will be complementary to produce quality and sustainable innovation (Birgili, 2015), so that it needs to be empowered in learning. The thinking skills which are integrated at every stage of inquiry syntax ease the students to manage and to understand information effectively and systematically. The ability to manage and understand information is the key for achieving creative thinking and critical thinking aspects. Critical thinking and creative thinking have a central role in education (Iakovos, 2011). On the other hand, Baker and Rudd (2001) argued that creative thinking and critical thinking were both convergent. The results of this research prove that the implementation of inquiry learning strategy can empower and develop the critical thinking and creative thinking, complement to each other to produce quality and sustainable innovation, and contribute to students' cognitive learning results.

Based on the results and discussion of this research, it can be concluded that: (1) critical thinking skills and creative thinking skills simultaneously have a significant correlation with cognitive learning results at the implementation of inquiry learning

strategy, (2) the contribution of the correlation between critical thinking and creative thinking skills simultaneously toward cognitive learning results at the implementation of inquiry learning strategy is as much as 72.80%, and (3) the effective contribution of creative thinking skills toward cognitive learning results is greater (64.91%) than that of the critical thinking skills (7.89%) to cognitive learning outcomes.

Empowering critical thinking skills and creative thinking skills by using the right learning strategy should be the focus of attention of educators, researchers and educational developers. This is based on the research results that critical thinking skills and creative thinking skills have a big contribution toward cognitive learning results with the implementation of inquiry strategy. Lecturers can consider the inquiry strategy as an alternative learning strategy to empower students' critical thinking skills and creative thinking skills, especially for new students in universities. This research is limited yet to the new students in universities. The research may be more interesting if applied at all levels of lectures in relation with other thinking skills.

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