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Critical Thinking, Creative Thinking, and Learning Achievement: How They are Related

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Abstract. This study aimed to investigate the correlation between (1) critical and creative thinking skills; (2) critical thinking skills and learning achievement; (3) creative thinking skills and learning achievement; and (4) critical thinking, creative thinking, and learning achievement. The current study was conducted in April 2019 and employed a correlational research design. The participants of this study consisted of 30 fourth-semester students from the Department of Biology Education of IKIP Mataram, Indonesia, who were currently studying Plant Physiology. Data were collected using a test that contained 19 essay questions on photosynthesis. The critical thinking instrument was composed of five aspects, whereas the creative thinking instrument comprised of eight aspects. Besides, the instrument used to determine learning achievement incorporated six aspects. Each of the elements was represented by one test item. The results of the data analysis indicated correlations between (1) critical and creative thinking skills; (2) critical thinking skills and learning achievement; (3) creative thinking skills and learning achievement; (4) creative thinking, critical thinking, and learning achievement. Since critical and creative thinking skills affect learning achievement, the empowerment of these skills may lead to the enhancement of learning achievement.

1. Introduction

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 [1]. Critical thinking is one of the high-level skills that is the goal of world education today, but this skill is not well developed in students. This is evidenced by the results of research that shows 75.63% of students in Public Junior High School 1 Turen have critical thinking skills that are still undeveloped or are still low [2]. Critical thinking skills of Public Senior High School students in Batu City in Biology are still not well developed and even need to be improved [3]. Based on the results of observations and interviews with eleventh-grade students in biology class at Public Senior High School 1 Alla in Enrekang Regency, it was obtained information that students' critical thinking skills are qualitatively relatively low [4]. Also, the students' critical thinking skills in science subjects in one of the Public Junior High Schools in Sukabumi City were still low [5]. Moreover, the results of research at Islamic Senior High School in Magetan Regency provide information that critical thinking skills of students are still low [6]. The results of other studies also show a phenomenon that is not much different.



Low critical thinking skills are also experienced by students who are the output of the senior high school. This is seen from the results of the previous researches. Based on the results of the study as a whole in the Biology education program of STKIP Bima, it was found that students' critical thinking skills were in a low category [7]. Besides, the results of research on 139 students from UIN Alauddin Makassar, STKIP PI Makassar, UPRI Makassar, and STKIP Yapim Maros, showed that critical thinking skills were still low and did not develop well [8]. The results of the research at the Biology Education Bachelor degree program at PGRI University Ronggolawe Tuban also showed that students still had difficulty using critical thinking skills [9]. The prospective teachers' critical thinking in Biology Department IKIP Mataram is underdeveloped [10]. The results of research at Biology Department IKIP Mataram showed that prospective science teachers' critical thinking disposition generally neither strength nor weakness category [11].

Another skill that needs to be developed in students is creative thinking. Creative thinking skills are the basis of science, which is very important for students [12]. Optimization of higher-order thinking skills is essential because it is a life skill that needs to be developed. It is required to overcome complex problems along with the times, especially in this 21st-century era [13]. The results of research on students at UNS show their creative thinking skills are insufficient category and still need to be developed [14]. Besides, the effects of research on Chemistry students at Sriwijaya University also showed that their creative thinking skills were at moderate and low levels [15].

Student learning outcomes are also significant to be a concern because one of the benchmarks of learning success is student learning outcomes related to the material being studied. Several research results show that learning outcomes in biology are still low in students and college students. The results of research at Public Senior High School 2 Surakarta show that student learning outcomes in biology subjects are still low and need to be appropriately handled [16]. The results of research at Biology students at the Muslim University of Maros in the Plant Ecology course show that their average learning outcomes are in the moderate category [17]. Therefore, biology learning outcomes need to be improved because they are still in the low and medium categories.

Facts about the low critical thinking skills, creative thinking skills, and learning outcomes also occur in the Biology IKIP education study program Mataram, seen from the results of observations and preliminary studies conducted on April 8-13, 2019, on students and interviews with lecturers of Plant Physiology courses. The course lecturers said that students were not accustomed to using their critical thinking skills and creative thinking well. It can be seen from their answers during midterm that some of which were theoretical because they could not analyze, evaluate, and conclude well. Besides, students still answer precisely like the material in textbooks, so the answers are still monotonous and less varied, especially on complex material, namely material in the Plant Physiology course.

The explanation above shows that critical and creative thinking skills are skills that are very needed in the 21st-century life so that a study of student learning outcomes is needed as a benchmark of learning. Therefore, a research is required in order to see: (1) the correlation between critical thinking skills and creative thinking skills; (2) the relationship of critical thinking skills to learning outcomes; (3) the relationship of creative thinking skills to learning outcomes; (4) the relationship between critical and creative thinking skills on learning outcomes.

2. Method

The design of this study used a correlational research design, which aimed to determine the extent to which one variable is related to other variables. Data collection was carried out in the Biology Education Study Program of IKIP Mataram in the academic year 2018/2019, on 22-27 April 2019. The sampling technique was done by saturation sampling (population sample), where all population members were sampled. Participants in this study were students who took Plant Physiology courses in semester 4, as many as 30 students, four males, and 26 females. The material being tested is Photosynthesis.

Data collection instruments for critical thinking skills using a rubric developed by Greenstein [18]. The assessment of critical thinking skills consisted of 4 scores (1-4) as a reference to examine each item with criteria (4 = perfect, 3 = good, 2 = enough, 1 = less), consisting of apply, evaluate, use data to

develop critical insights, analyze, synthesize. The instruments for creative thinking skills are curiosity, fluency, originality, elaboration, flexibility, divergence, messiness/risk-taking, with others [18], the assessment of creative thinking skills consisted of 4 scores (1-4) as a reference to check each item with criteria (4 = very good, 3 = good, 2 = enough, 1 = less). Besides, learning outcomes referred to Benjamin S. Bloom [19], consisting of remembering, understanding, applying, analyzing, evaluating, and creating, while the assessment for cognitive learning outcomes with a range of values from 0-100. All questions were in the form of essay tests taken from photosynthetic material that has been previously validated.

Data collected was in the form of quantitative data and analyzed statistically. Data analysis used multiple regression analysis to reveal the correlation between critical thinking skills, creative thinking skills, and student cognitive learning outcomes. The data analysis process was assisted by SPSS version 18.0 for windows at a significance level of 5%.

3. Results and Discussion

The results of data analysis and discussion were presented sequentially. The results of the correlation between critical thinking skills with creative thinking skills are given as follows.

Table 1. The Correlation Results Between Critical Thinking Skills and Creative Thinking Skills.

Model	Sum of Squares	df	Mean Square	F	Sig 2-tiled
Regression	785.952	1	785.952	7.281	.012
Residual	3022.590	28	107.950		
Total	3808.542	29			

Table 1 shows that $p = 0.012$, which means that there is a correlation between critical thinking skills and creative thinking skills. The regression coefficient of the relationship between critical thinking skills and creative thinking skills of 0.454 is shown in Table 2.

Table 2. The Regression Coefficient of Critical Thinking Skills and Creative Thinking Skills

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	29.302	7.513		.454	.001
Critical Thinking Skills	.360	.133		2.698	.012

a. Dependent Variable: Creative Thinking Skills

The total contribution of critical thinking skills to creative thinking skills is shown in Table 3.

Table 3. The Results Summary of Regression Analysis of Critical Thinking Skills and Creative

R	R Square	Adjusted R Square	Std. Error of the Estimate
.454 ^a	.206	.178	10.390

a. Predictors: (Constant), Critical Thinking Skills

The results of the multiple regression analysis show that the regression coefficient value (R) is 0.454, and the determination coefficient is (R²) 0.206. This means that the contribution of critical thinking skills to creative thinking skills is 20.60%, while the remaining as much as 79.40% is influenced by other variables.

Critical thinking skills and creative thinking skills are related to each other. When a person starts thinking, there is a disequilibrium process in his brain so that someone can bring up things that are

different from usual. In line with the results of the above study, it has also been found that there is a significant correlation between critical thinking skills and creative thinking skills on cognitive learning outcomes through inquiry learning in environmental science courses [20].

The development of science in the 21st century has given rise to a sense of urgency in students, primarily to obtain specific skills needed in a career [21]. These skills include critical thinking skills, communication skills, teamwork skills, and creativity [22]. Therefore, the empowerment of thinking skills, especially critical and creative thinking, is needed.

Table 4. The Data Analysis Results of Correlation between Critical Thinking Skills and Cognitive Learning Outcomes.

Model	Sum of Squares	df	Mean Square	F	Sig 2-tiled
Regression	3438.328	1	3438.328	84.020	.000
Residual	1145.838	28	40.923		
Total	4584.167	29			

Table 4 shows that $p = 0.000$, which means that there is a correlation between critical thinking skills with cognitive learning outcomes. The regression coefficient of the relationship between critical thinking skills and learning outcomes of 0.866 is shown in Table 5.

Table 5. The Regression Coefficient of Critical Thinking Skills and Cognitive Learning Outcomes

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	16.807	4.626		3.633	.001
Critical Thinking Skills	.753	.082	.866	9.166	.000

a. Dependent Variable: Learning Outcomes

The total contribution of critical thinking skills to cognitive learning outcomes is shown in Table 6.

Table 6. The Results Summary of Regression Analysis of Critical Thinking Skills and Cognitive Learning Outcomes.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.866 ^a	.750	.741	6.39709

a. Predictors: (Constant), Critical Thinking Skills

The results of the multiple regression analysis show that the regression coefficient value (R) is 0.866, and the determination coefficient is (R²) 0.750. This means that the contribution of critical thinking skills to cognitive learning outcomes is 75.00%, while the remaining as much as 25.00% is influenced by other variables.

Critical thinking skills are needed in welcoming the 21st century so that students are expected to get meaningful learning and practice these critical thinking skills in learning. In empowering critical thinking skills, there will be learning outcomes that follow as a form of learning outcomes. However, based on the results of the 2018 National Examination, students were still weak in higher-order thinking skills such as reasoning, analyzing, and evaluating [23].

One of the competencies for sustainability is the ability to think critically about norms, opinions, and actions; reflect the values, perceptions, and activities that become his beliefs [15]. Critical thinking will support the process of thinking that is fast, accurate, and without assumptions [24]. The government expects students to achieve various competencies with the application of HOTS or Higher Order Thinking Skills [25]. These competencies are critical thinking, creative and innovative, communication

skills, the ability to work together (collaboration), and confidence. In addition to students, college students are also required to be able to analyze, synthesize, and infer the information obtained with the ability to think critically, so students can distinguish between good and bad news, and can make decisions about the information obtained through critical thinking [26].

Table 7. The Correlation Analysis Results Between Creative Thinking Skills and Cognitive Learning Outcomes.

Model	Sum of Squares	df	Mean Square	F	Sig 2-tiled
Regression	676.030	1	676.030	4.843	.036
Residual	3908.137	28	139.576		
Total	4584.167	29			

Table 7 shows $p = 0.036$, which means that there is a correlation between creative thinking skills and cognitive learning outcomes. The regression coefficient of the relationship between creative thinking skills and cognitive learning outcomes of 0.384 is shown in Table 8.

Table 8. The Regression Coefficient of Creative Thinking Skills and Cognitive Learning Outcomes.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	37.224	9.610		3.874	.001
Creative Thinking Skills	.421	.191	.384	2.201	.036

a. Dependent Variable: Learning Outcomes

The total contribution of creative thinking skills to cognitive learning outcomes is shown in Table 9.

Table 9. The Summary of Regression Analysis Results of Creative Thinking Skills and Cognitive Learning Outcomes

R	R Square	Adjusted R Square	Std. Error of the Estimate
.384 ^a	.147	.117	11.81424

a. Predictors: (Constant), Creative Thinking Skills

The results of the multiple regression analysis show that the regression coefficient value (R) is 0.384 and the determination coefficient is (R²) 0.147. This means that the contribution of creative thinking skills to cognitive learning outcomes is 14.70%, while the remaining as much as other variables influence 85.30%.

Creative thinking skills that are trained in schools will make students have creativity [16]. Another opinion says that the development of cognitive learning outcomes is considered vital because it is often associated with children's intelligence [27]. Therefore, between creative thinking skills and learning outcomes need to be harmonized in learning, both for students and college students, and this is the task of educators, namely teachers and lecturers.

Table 10. The Correlation Analysis Results of Critical Thinking Skills and Creative Thinking Skills Against Cognitive Learning Outcomes.

Model	Sum of Squares	Df	Mean Square	F	Sig 2-tiled
Regression	3438.839	2	1719.420	40.534	.000
Residual	1145.327	27	42.420		
Total	4584.167	29			

Table 10 shows $p = 0,000$, which means that there is a significant correlation between critical thinking skills and creative thinking skills on cognitive learning outcomes. The regression coefficient of the relationship between creative thinking skills and learning outcomes is 0.012, while the regression coefficient of the correlation between critical thinking skills and learning outcomes of 0.871 is shown in Table 11.

Table 11. The Regression Coefficient of Critical Thinking Skills and Creative Thinking Skills Against Cognitive Learning Outcomes.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	17.188	5.851		2.938	.007
Creative Thinking Skills	-.013	.118	-.012	-.110	.913
Critical Thinking Skills	.757	.094	.871	8.070	.000

a. Dependent Variable: Learning Outcomes.

The total contribution of critical thinking skills and creative thinking skills to cognitive learning outcomes is shown in Table 12.

Table 12. The Summary of the Regression Analysis Results of Critical Thinking Skills, Creative and Learning Outcomes

R	R Square	Adjusted R Square	Std. Error of the Estimate
.866 ^a	.750	.732	6.51303

a. Predictors: (Constant), Critical Thinking Skills, Creative Thinking Skills

The results of the multiple regression analysis show that the regression coefficient value (R) is 0.866, and the determination coefficient is (R^2) 0.750. This means that the contribution of critical thinking skill and creative thinking skill to cognitive learning outcomes is 75.00%, while the remaining as much as other variables influence 25.00%.

Almost all levels of education have the same problems regarding critical thinking skills, ranging from high school students, college students, and prospective teachers. Research conducted by [28] shows that prospective teachers have a low level of critical thinking disposition in general. Based on the World Economic Forum, to face of the industrial revolution 4.0, the capabilities needed include the ability to solve problems, critical thinking, creativity, management, coordinating with others, emotional intelligence, evaluating and making decisions, service orientation, negotiating, and cognitive flexibility [15]. This capability is needed to adapt to the latest technological advancements. One effort in the field of education that can be done to produce high-quality human resources is by making a culture of critical thinking as a habit for students in the learning process [26]. Therefore, an education expert John Dewey, from the earlier expects that students are taught critical thinking skills [29].

Creative and critical thinking skills are considered essential for students [24]. Crane stated the importance of these two skills when he wrote: "When reason fails, imagination saves you! When intuition fails, the idea keeps you!" The results of meaningful learning will tend to be useful, both in cognitive, practical, and psychomotor aspects [30]. Meanwhile, creative thinking is different from critical thinking that is convergent. Creative thinking tries to create something new, while critical thinking tries to assess value or validity in something that exists. Creative thinking is done by violating

accepted principles, while critical thinking is done by applying accepted principles. Creative and critical thinking may be different sides of the same coin as they are not identical. The explanation reveals the importance of critical thinking skills and creative thinking skills to be aligned in learning.

Learning activities that can empower critical and creative thinking skills are innovative learning. One of which is inquiry learning strategies, because it can create meaningful and effective knowledge of critical thinking skills and creative thinking skills [31]. Lecturers can consider inquiry strategies as alternative learning, especially for new students at the university, to empower critical thinking skills and creative thinking skills. It is based on research results that inquiry strategies have a significant contribution to cognitive learning outcomes. Another type of innovative learning that could be an alternative is the Multiple Representation Based Learning (MRL) model [32].

MRL is a learning model of Multiple Representation Based Learning. Based on the results of the study, MRL is the most effective model for improving students' understanding of concepts compared to Problem Based Learning (PBL) and Direct Learning (DL) [32]. Several studies on Multi Representation Based Learning show that MRL has been able to improve students' higher-order thinking skills [33-35]. The MRL model is an effective learning model to optimize students' imagination abilities that can increase the students' ability to think and reason in solving problems [35]. Sunyono suggested applying MRL to material involving macro, submicron, and symbolic phenomena because students can learn with a variety of very important representations, and can stimulate students' interest in seeking information [32]. Those models can encourage teachers to develop critical thinking skills, creative thinking skills, and learning outcomes of students.

4. Conclusion

Correlation analysis results show: (1) there is a significant correlation between critical thinking skills with creative thinking skills of students. The amount of contribution by given critical thinking skills to creative thinking skills was 20.6%, with the equation of the regression line $Y = 0.360 X + 29.302$. (2) There is a significant correlation between critical thinking skills and learning outcomes. The amount of contribution given by critical thinking skills to learning outcomes was 75.0% with a regression line equation that is $Y = 0.753 X + 16.807$. (3) There is a correlation between creative thinking skills and learning outcomes. The amount of the contribution given by creative thinking skills to learning outcomes is 14.7% with a regression line equation that is $Y = 0.421 X + 37.224$. (4) There is a correlation between critical and creative thinking skills in learning outcomes. The total amount of contribution given by critical thinking skills and creative thinking skills to learning outcomes is 75.0% with the regression line equation that is $Y = 0.757 X + 17.188$ and $Y = 0.013 + 17,188$. Overall, it can be concluded that there is a significant correlation between critical thinking skills, creative thinking skills with student cognitive learning outcomes. Thus, it is necessary to empower thinking skills in learning to further enhance critical and creative thinking skills, as well as learning outcomes by using innovative learning. This recommendation is used to improve the quality of learning.

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