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Relationship between Critical and Creative Thinking Skills and Learning Achievement in Biology with Reference to Educational Level and Gender

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ABSTRACT
The purpose of this study was to understand the relationship between critical and creative thinking skills and learning achievement of senior high school and university students of both genders. The sample consisted of 85 senior high school and 90 university students drawn using cluster random sampling. Senior high school level samples were drawn from senior high schools in the city of Tebing Tinggi, while university level samples were drawn from the Jember state Islamic institute. Regression analysis was applied to understand the correlations among educational level and gender differences in the relationship between critical and creative thinking skills and learning achievement. The results show that senior high school and university students' critical thinking skills correlated positively with both creative thinking skills and learning achievement for both genders. Furthermore, senior high school and university students' creative thinking skills show significantly positive relationships with learning achievement in both sexes.

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Introduction

Based on the Programme for International Student Assessment (PISA) conducted by the Organisation for Economic Cooperation and Development (OECD), thinking skills (critical and creative) of Indonesian high school students were ranked 39th out of 41 countries in 2009, 63rd out of 64 countries in 2012, and 60th out of 65 countries in 2015 (OECD, 2010; OECD, 2013; OECD, 2016). Several studies have found that Indonesian school students' creative thinking skills (CreTS) are unsatisfactory at various academic levels in biology (Carni, 2017; Dewi, 2019; Nasution, 2017; Nurani,

2014; Puspitasari, 2017; Putra, 2016; Suparman, 2015; Purnamaningrum, 2012; Tamba, 2017; Wahyu, 2017). These findings suggest that Indonesian schoolchildren's thinking skills and learning achievement (LA) in mathematics and science are substantially lower than those of pupils in other OECD nations.

Creative thinking skills (CreTS) are a set of abilities in providing various kinds of possible solution based on information provided by involving the construction of ideas that emphasise aspects of fluency, flexibility, novelty and detail (Isaken, 1995; Munandar, 1999). Creativity is a crucially essential skill in today's era and is receiving commensurate attention in education (Henriksen et al., 2016; Shabrina & Kuswanto, 2018; Wilson & Peterson, 2006). Students with well-developed CreTS will demonstrate flexibility and see opportunities as well as face challenges in a world that is continuously developing rapidly (Ritter & Mostert, 2016). CreTS is one of the core skills needed in 21st-century learning (Darmawan, 2016; Greenstein, 2012; OECD 2013; Syaibani, 2017).

CreTS is one of the essential skills in biology education. This skill helps students in solving problems, providing new ideas and taking decisions on the various situation (Sarwinda, 2013). These skills help students to fulfil their self-actualization. Students with excellent CreTS may be more interested in learning, especially something that he/she is passionate about, and ultimately will improve their quality of life (Citra, 2016; Darmadi, 2018). All people possess the capacity for creative thinking, and this capacity may be enhanced via education (Ülger, 2016), including curriculum, learning environment, learning methods and models, instructional media, government and societal assistance. Students' limited capacity for creative thinking may also be explained by a lack of or infrequent exposure to educational coursework aimed at developing their CriTS. Teachers should be able to integrate training to help pupils develop their ability to think creatively into their classroom teaching.

Previous studies found that school students' learning achievement (LA) in Indonesia is comparatively low (Ali, 2017; Anwar, 2017; Ardilla, 2013; Jafar, 2018; Nasution, 2017; Nurkholis, 2018; Suhartiningsih, 2018; Rahmawati, 2018). Learning Achievement is an outcome of the learning process (Lizzio et al., 2002) following a specific teaching unit (Harahap et al., 2019). Learning achivement is in the cognitive domain is one of the areas of learning achievement (Harahap et al., 2019). In Anderson's (2001) revised Bloom's Taxonomy, LA relates to Remembering (C1), Understanding (C2), Applying (C3), Analysing (C4), Evaluating (C5) and Creating (C6).

Similar to creative thinking skills, critical thinking skills (CriTS) appear as an essential 21st-century cognitive area (Berliner, 2009). Critical thinking is one of the important elements of scientific thinking (Azar, 2010; Mahanal, 2019). CriTS helps people to solve challenges and problems in everyday life or the workplace and one of the primary skills in 21st-century learning (Abdurrahman, 2019; Greenstein, 2012; Irwanto, 2019; Muhlisin, 2016; OECD, 2013; Rotherham & Daniel, 2009; Sadhu & Laksono, 2018). CriTS are a reasonable, purposeful introspective approach to solving problems or answering questions based on present evidence and information (Rudd, 2000).

Walker (2005) specifies critical thinking as a quick process in constructing a concept, applying it, analysing it, synthesising it and evaluating information obtained from observation, experience and reflections. When CriTS are integrated into learning, students will be academically and socially successful (Kökdemir, 2003). By having CriTS, students will have profound and clear thoughts, they will be more interested in an activity, they will take the right approach, and they will be wiser (Connerly, 2006). CriTS can be improved through various aspects of education, such as the curriculum, learning environment, learning strategies and models, instructional media and the support of government and society. Students' weak critical thinking abilities may also be explained by their lack of or infrequent exposure to educational instruction designed to improve their CriTS. Teachers should be able to incorporate training to enhance students' CriTS into their classroom instruction.

There are different ways in which CriTS, CreTS and LA can interrelate, positive correlation, negative correlation, or no correlation. CriTS may have an important role in influencing CreTS (Kamaei, 2013) and LA (Fero et al., 2010; Gharzakili, 2014; Jufrina, 2016; Kamaei, 2013; Taghva, 2014;

Wan, 2018). According to Schafersman (1991), when a person thinks critically, he or she may transform knowledge creatively. Ülger (2016) also stated that in terms of thinking abilities, critical thinking as potentially thinking cannot be separated from creative thinking. CreTS also may influence LA (Anwar, 2017; Herlina, 2017; Nuriadin, 2013; Nursofah, 2018; Vasudevan, 2013). Conversely, neither CriTS nor CreTS may directly influence LA (Anwar, 2017; Herlina, 2017; Kanbay et al, 2017; Nuriadin, 2013; Nursofah, 2018; Vasudevan, 2013;). The third conclusion is that there is no correlation, students' CriTS or CreTS are not a factor in determining LA (Aghaei et al, 2012; Ai, 1999; Azodi et al, 2010; Behroozi, 1997; Edwards, 1965; Mayhon, 1966; Nori, 2002; Tanprahat, 1976; Torrance, 1962; Shirazi, 2019).

Greenstein (2012) stated there are five CriTS aspects: (1) Application, involving finding and using information and data from various sources; (2) Evaluation, involving comparing and differentiating between criteria and views; (3) Using data to develop critical insight, to produce correct conclusions based on available data; (4) Identifying and analysing the main problem, determining priorities, seeing implications that are not mentioned, and understanding complex ideas from various viewpoints; and (5) Synthesising, involving comparing components of arguments to arrive at integrated conclusions.

Greenstein (2012) determined six CreTS aspects: (1) Curiosity, an active interest in discovering new elements and ideas; (2) Fluency, being able to see things from multiple perspectives; (3) Originality in the production of new ideas; (4) Elaboration, students find it simple and enjoyable to improve anything by adding details; (5) Flexibility, adapting to new situations well; (6) Divergent, as shown by combining, modifying and adapting ideas towards improving outcomes.

As noted earlier, some prior research has reached conflicting conclusions regarding the relationship between CriTS, CreTS and LA. One possible reason is the diverse background characteristics of school students. Gender is one of the most important and frequently stated background characteristics (e.g., Ai, X., 1999; Naderi, et al 2009). Ai (1999) found that when examining the relationship between creativity and academic achievement, it is important to consider the different aspects of creativity.

There is a dearth of research on gender differences in the relationship between CriTS, CreTS and LA in the context of biology education. Along with gender, as suggested by earlier studies, educational level has the potential to be a determinant in this issue. Naderi et al (2009) stated that when students reach higher levels of education, the connections between academic performance and creativity seem to deteriorate. There is a lack of research on the connections between CriTS, CreTS and LA in biology students. By comparing senior high school students and higher education students to determine which elements of CriTS, CreTS and LA are more closely related to one another, the findings of this study may shed light on the conflicting conclusions. Eventually, this study may assist educators in selecting the most appropriate learning strategies for students by taking into account their gender and educational level.

The Aims of the Study

The following are the research questions that underpin this study:

1. What are the levels of students' critical thinking skills, creative thinking skills, and learning achievement at Tebing Tinggi senior high school and Jember state Islamic institute?
2. Does the level of education and gender of students at Tebing Tinggi senior high school and Jember state Islamic institute influence the relationship between critical and creative thinking skills and learning achievement?

Methods

Research Design

This study used a quantitative methodology approach. Using regression analysis, the correlations between variables were identified.

Participants

We tested 80 students (Male=12, female=68) enrolled in the Biology Education Programme in the Faculty of Education and Teacher Training at IAIN Jember University and two classes at Tebing Tinggi Senior High School totalling 85 students (Male=35, female=50). The samples for this study were drawn from high school and university students majoring in natural science. The participants were selected by using cluster random sampling technique (McMillan & Schumacher, 2006). All participants were willing to take part in this investigation.

Test Instruments

This study utilised three different test instruments to assess high school and university students' CriTS, CreTS and LA. The first test instruments is the test of critical thinking skills comprised of five essay questions that addressed all indicators adopted by Greenstein (2012; application, evaluation, using data to develop critical insight, analysis and synthesis). The second test instruments is the test of creative thinking skills comprised of six essay questions that addressed all indicators adopted by Greenstein (2012; curiosity, fluency, originality, elaboration, flexibility and divergence).

Greenstein's (2012) marking key was used to asses answers, students scored zero (0) if the question had not been answered, one (1) if the answer was categorised at the a novice level, two (2) if the answer was classified as basic, three (3) if the answer was categorised as proficient, and four (4) if the answer was categorised as exemplary. The marking key was applied by two expert assessors working independently. Two expert assessors were asked to read Greenstein's (2012) rubric for critical thinking skills and creative thinking skills and to compare their perceptions of the marking key prior to conducting the assessment. In the event that the outcomes of the evaluation are not same, the two experts must re-discuss using the Greensten's (2012) rubric until they arrive at the same mark. The third test instruments is the LA test consisted of 12 essay questions with a maximum score of 100.

All test instrument covered all aspects of basic biology found in the Indonesian university biology education and high school biology curricula from 2013. These are cells, cellular processes, and animal locomotory and circulatory systems. The difficulty level of questions was different between senior high school and university instrument test. The test was developed over the course of three months by analyzing available national exam questions and collegiate examinations. The content and face validity of all the test were checked by lecturers in biology education at State University of Malang and IAIN Jember University and some items were accordingly revised.

Data Analysis

Following the completion of the questionnaires, the data were analyzed using SPSS software Version 25. Table 1 summarises the descriptive statistics and Cronbach's alpha coefficient data for the test instrument. Cronbach's alpha values greater than 0.6 are considered to show an acceptable degree of reliability (Ursachi et al, 2005). Cronbach's alpha values for all instrument tests in this study were greater than 0.6. This indicates that the instrument test's items in all variables have a high degree of reliability.

Table 1

Descriptive Statistics, and Cronbach Alpha Coefficient Value

Test	Item	Senior High School			University		
		Mean	SD	Alpha	Mean	SD	Alpha
Critical thinking skills	1	58.24	.79	.874	59.69	.8	.798
	2	51.47	.88		54.06	.68	
	3	51.47	.86		51.25	.73	
	4	46.18	.84		49.06	.63	
	5	47.06	.89		47.19	.67	
Creative thinking skills	1	58.82	.8	.857	56.25	.67	.72
	2	55	.78		56.56	.71	
	3	53.53	.77		44.06	.75	
	4	47.35	.64		55.94	.72	
	5	48.24	.7		50.31	.68	
	6	47.35	.67		50	.57	
Learning achievement	1	69.4	.464	.611	68.8	.466	.617
	2	69.4	.464		67.5	.471	
	3	62.4	.487		68.8	.466	
	4	58.8	.495		57.5	.497	
	5	58.8	.495		61.3	.490	
	6	52.9	.502		55	.501	
	7	50.6	.503		57.5	.497	
	8	44.7	.5		42.5	.497	
	9	50.6	.503		52.5	.503	
	10	35.3	.481		40	.493	
	11	42.4	.497		51.3	.503	
	12	42.4	.497		41.3	.495	

Two techniques were used in this study to determine whether or not the data had a normal distribution. To begin with, we determined the skewness and kurtosis values. Normal distribution was assumed if the skewness values were between -1 and 1 (Tabachnick & Fidell, 2013). Next, the Kolmogorov-Smirnov Test was conducted. If the calculated p-value is higher than .05, the scores do not deviate significantly from the normal distribution at that level of significance (Büyüköztürk, 2010). The normality test results for the data in this research are shown in table 2.

Table 2

Evaluating the Normal Distribution Assumption for Instrument Test Data

Variable	Education level	Gender	N	Skewness	Kurtosis	Kolmogorov Smirnov
Critical thinking skills	Senior High School	Male	35	.352	-1.036	.053
		Female	50	.23	-1.086	.197
		All	85	.294	-.991	.053
	University	Male	12	.101	-.224	.2*
		Female	68	-.023	-.237	.068
		All	85	-.171	-.126	.2*

Creative thinking skills	Senior High School	Male	35	-.051	-.98	.073
		Female	50	-.03	-.589	.2*
		All	85	-.023	-.785	.073
	University	Male	12	.159	-1.118	.057
		Female	68	.264	-.321	.2*
		All	85	.172	-.292	.057
Learning achievement	Senior High School	Male	35	-.096	-.748	.2*
		Female	50	-.045	-.94	.2*
		All	85	-.067	-.881	.2*
	University	Male	12	.255	-.996	.174
		Female	68	-.092	-1.599	.062
		All	85	-.21	-1.401	.174

The skewness of the variables in this research ranges from .023 to .35, and the Kolmogorov-Smirnov level of significance is higher than .05. As a conclusion, the data in this research are assumed to have a normal distribution. Therefore, parametric tests were preferred in the data analysis. Regression Analysis was applied to understand the correlations among educational level and gender differences in the relationship between CriTS, CreTS, and LA. Additional information arising from this research are the CriTS, CreTS, and LA profiles at the two different academic levels represented.

Findings

Critical Thinking Skills

The results of the CriTS test are shown in Table 3.

Table 3

Critical Thinking Skills Test Result

No.	Indicators	Senior High School Students			University Students		
		All	Male	Female	All	Male	Female
1	Apply	58.24	61.43	56	59.69	66.67	58.46
2	Use data to develop critical insight	51.47	57.86	47	54.06	62.5	52.57
3	Synthesize	51.47	55	49	51.25	52.08	51.1
4	Analysis	46.18	45	47	49.06	54.17	48.16
5	Evaluation	47.06	47.86	46.5	47.19	56.25	45.59
	Mean	50.88	53.43	49.1	52.25	58.33	51.18

As displayed in Table 3, the average of critical thinking skills test result for senior high school was 50.8 (Male: 53.43, Female: 49.1) and for university students was 52.25 (Male: 58.33, Female: 51.18). The findings of a t-test indicated that there were no statistically significant differences between the senior high school and university students on a test of critical thinking skills (p =.568). The findings of a t-test indicated that there were no statistically significant differences between the male and female students on a test of critical thinking skills (p =.262 for senior high school; p =.081 for university ; p =.111 for both).

Creative Thinking Skills

The results of the CreTS test are shown in Table 4.

Table 4

Creative Thinking Skills Test Result

No.	Indicators	Senior High School Students			University Students		
		All	Male	Female	All	Male	Female
1	Curiosity	58.82	58.57	59	56.25	66.67	54.41
2	Fluency	55	58.57	52.5	56.56	64.58	55.15
3	Elaboration	53.53	55.71	52	44.06	47.92	43.38
4	Originality	47.35	49.29	46	55.94	58.33	55.51
5	Flexible	48.24	49.29	47.5	50.31	45.83	51.1
6	Divergent	47.35	45.71	48.5	50	50	50
	Mean	51.72	52.86	50.92	52.19	55.56	51.59

As displayed in table 4, the average of CreTS test result for senior high school was 51.72 (Male: 52.86, Female: 50.92) and for university students was 52.19 (Male: 55.56, Female: 51.59). The findings of a t-test indicated that there were no statistically significant differences between the senior high school and university students on a test of creative thinking skills ($p = .809$). The findings of a t-test indicated that there were no statistically significant differences between the male and female students on a test of creative thinking skills ($p = .623$ for senior high school; $p = .255$ for university ; $p = .304$ for both).

Learning Achievement

The results of the learning achievement test are shown in Table 5.

Table 5

Learning Achievement Test Result

No.	Indicators	Senior High School Students			University Students		
		All	Male	Female	All	Male	Female
1	Remembering	69.41	74.29	66	68.13	70.83	67.65
2	Understanding	57.25	58.1	56.67	61.25	69.44	59.8
3	Applying	52.16	54.29	50.67	52.92	63.89	50.98
4	Analysing	46.47	47.14	46	51.88	54.17	51.47
5	Evaluating	42.35	45.71	40	41.25	41.67	41.18
6	Creating	35.29	37.14	34	40	41.67	39.71
	Mean	50.49	52.78	48.89	52.57	56.94	51.8

As displayed in table 5, the average of LA test result for senior high school was 50.49 (Male: 52.78, Female: 48.89) and for university students was 52.57 (Male: 56.94, Female: 51.8). The findings of a t-test indicated that there were no statistically significant differences between the senior high school and university students on a test of learning achievement ($p = .515$). The findings of a t-test indicated that there were no statistically significant differences between the male and female students on a test of learning achievement ($p = .451$ for senior high school; $p = .079$ for university ; $p = .304$ for both).

Correlation Analysis of Critical Thinking Skills and Creative Thinking Skills

The results of the regression analysis of CriTS and CreTS are shown in Table 6.

Table 6

Regression Analysis of Critical Thinking Skills and Creative Thinking Skills

No.	Variables		Creative thinking skills					
	Critical thinking skills		β	ϱ	F	P	R2	Adjusted R2
1	Senior High School Students	All	.4	.001	15.84	.001	.16	.15
2		Male	.397	.018	6.179	.018	.158	.132
3		Female	.395	.005	8.863	.005	.156	.138
4	University Students	All	.619	.001	48.335	.001	.383	.375
5		Male	.643	.024	7.044	.024	.413	.355
6		Female	.609	.001	38.85	.001	.371	.361

As displayed in table 6, there is a correlation between senior high school students' CriTS and CreTS, with the significance (All: β=.4, ϱ<.01; Male: β=.397, ϱ<.05; Female: β=.395, ϱ<.01) and the regression equation is significant (All: F=15.84, p<.01; Male: F=6.179, p<.05; Female: F=8.863, p<.01). There is a correlation between university students' CriTS and CreTS, with the significance (All: β=.619, ϱ<.01; Male: β=.643, ϱ<.05; Female: β=.609, ϱ<.01) and the regression equation is significant (All: F=48.335, p<.01; Male: F=7.044, p<.05; Female: F=38.85, p<.01).

Correlation Analysis of Critical Thinking Skills and Learning Achievement

The results of the regression analysis of CriTS and LA are shown in Table 7.

Table 7

Regression Analysis of Critical Thinking Skills and Learning Achievement

No.	Variables		Learning achievement					
	Critical thinking skills		β	ϱ	F	P	R2	Adjusted R2
1	Senior High School Students	All	.57	.001	39.94	.001	.325	.317
2		Male	.496	.002	10.752	.002	.246	.223
3		Female	.618	.001	26.643	.001	.382	.369
4	University Students	All	.376	.001	12.88	.001	.142	.131
5		Male	.585	.046	5.192	.046	.342	.276
6		Female	.356	.003	9.603	.003	.127	.114

As displayed in table 7, there is a correlation between senior high school students' CriTS and LA, with the significance (All: β=.57, ϱ<.01; Male: β=.496, ϱ<.01; Female: β=.618, ϱ<.01) and the regression equation is significant (All: F=39.94, p<.01; Male: F=10.752, p<.01; Female: F=26.643, p<.01). There is a correlation between university students' CriTS and LA, with the significance (All: β=.376, ϱ<.01; Male: β=.585, ϱ<.05; Female: β=.356, ϱ<.01) and the regression equation is significant (All: F=12.88, p<.01; Male: F=5.192, p<.05; Female: F=9.603, p<.01).

Correlation Analysis of Creative Thinking Skills and Learning Achievement

The results of the regression analysis of CreTS and LA are shown in Table 8.

Table 8

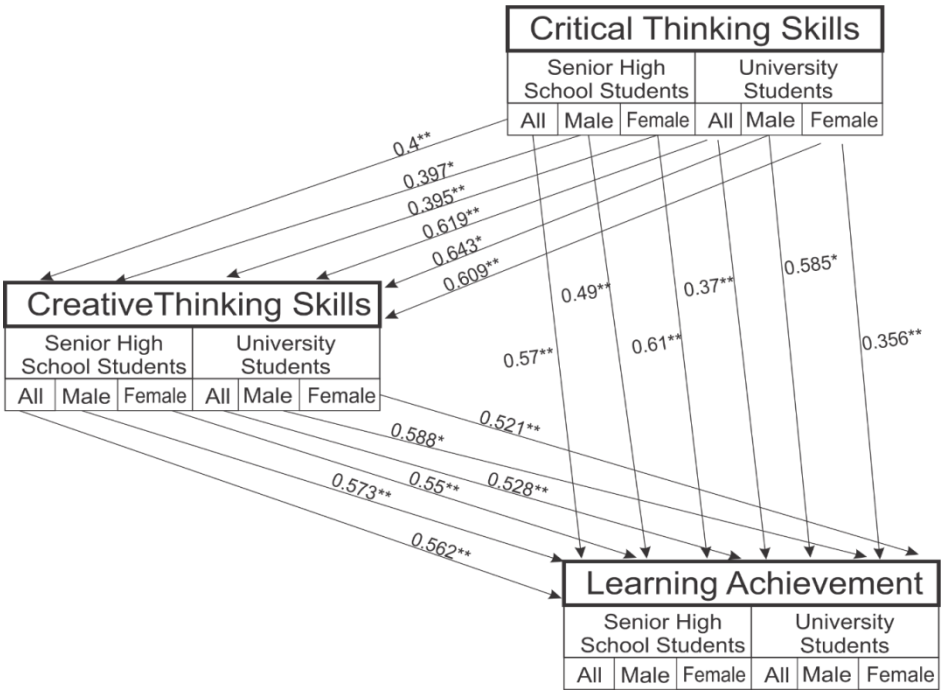
Regression Analysis of Creative Thinking Skills and Learning Achievement

No.	Variables		Learning achievement					
	Creative thinking skills		β	ϱ	F	P	R2	Adjusted R2
1	Senior High School Students	All	.562	.001	38.286	.001	.316	.307
2		Male	.573	.001	16.12	.001	.328	.308
3		Female	.55	.001	20.84	.001	.303	.288
4	University Students	All	.528	.001	30.183	.001	.279	.27
5		Male	.588	.044	5.278	.044	.345	.28
6		Female	.521	.001	24.641	.001	.272	.261

As displayed in table 8, there is a correlation between senior high school students' CreTS and LA, with the significance (All: β=.562, ϱ<.01; Male: β=.573, ϱ<.01; Female: β=.55, ϱ<.01) and the regression equation is significant (All: F=38.286, p<.01; Male: F=16.12, p<.01; Female: F=20.84, p<.01). There is a correlation between university students' CreTS and LA, with the significance (All: β=.528, ϱ<.01; Male: β=.588, ϱ<.05; Female: β=.521, ϱ<.01) and the regression equation is significant (All: F=30.183, p<.01; Male: F=5.278, p<.05; Female: F=24.641, p<.01).

Figure 1

An Output Path Diagram Displaying the Path Coefficients and Path Analysis Senior High School And University Students' Critical Thinking Skills, Creative Thinking Skills, and Learning Achievement



Note. (* p<.05; ** p<.001)

The coefficients, as displayed in figure 1, stated positive effects between the predictor variables and the criterion variables. All of the path coefficients are greater than .05 (significant).

Therefore all paths are essential (Kerlinger & Pedhazur, 2009). This result suggests that senior high school and university students' CriTS predict CreTS and LA positively in both genders. This result also suggests that senior high school and university students' CreTS predict LA positively in both sexes. Generally, there is a correlation between CriTS, CreTS, and LA in male and female senior high school and university students.

Discussion

Critical Thinking Skills

The test score average of senior high school students' CriTS was 50.88 (Male=53.43 and female=49.1). At the university level, the test score average of students' CriTS was 52.25 (Male=58.33 and female=51.18). Greenstein's (2012) assessment says that a score of 50.88 and 52.25 shows that senior high school and university students' CriTS are at the basic level. Although this level is not as poor as the novice level, it would be preferable for students at these levels to operate at the thinking abilities are at least in proficient level or better.

There were no statistically significant differences between the senior high school and university students on a test of critical thinking skills (p =.568). There were no statistically significant differences between the male and female students on a test of critical thinking skills (p =.262 for senior high school; p =.081 for university ; p =.111 for both). The lowest average score category for university students and senior high schools' CriTS are 'evaluation' (47.19 and 47.06) and 'analysis' (49.06 and 46.18). This result indicates that students have low evaluation and analysis ability, consistent with Filsaime (2008), who states that the most complex critical thinking level is on the evaluation aspect.

Creative Thinking Skills

The average of senior high school students' CreTS is 51.72 (Male=52.86 and female=50.92). At the university level, the test score average of students' CreTS was 52.19 (Male=55.56 and female=51.59). Greenstein's (2012) assessment says that a score of 51.72 and 52.19 shows that senior high school and university students' CreTS are at the basic level. There were no statistically significant differences between the senior high school and university students on a test of creative thinking skills (p =.809). There were no statistically significant differences between the male and female students on a test of creative thinking skills (p =.623 for senior high school; p =.255 for university ; p =.304 for both).

The lowest average score category for university students CreTS are 'divergent' (50) and 'elaboration' (44.06) and for senior high school students are 'originality' and 'divergent' (both are 47.35). These findings indicate that students at both academic levels have low divergent thinking skills, which is consistent with Ismail et al. (2019)'s claim that the capacity to think divergently is the most advanced thinking ability in creative thinking.

Learning Achievement

The test score average of senior high school students' LA is 50.49 (Male=52.78 and female=48.89). This average score is unsatisfactory; it is only regarded pass. At the university level, the test score average of students' LA is 52.57 (Male=56.94 and female=51.8), this average score is still can be improved, remembering that LA is the benchmarks of learning quality. There were no statistically significant differences between the senior high school and university students on a test of LA (p =.515). There were no statistically significant differences between the male and female students on a test of LA (p =.451 for senior high school; p =.079 for university ; p =.304 for both).

University students' cognitive level lowest average scores were for C5 evaluating (48.7), C6 creating (75), and C4 analyzing (78.1) consecutively. Senior high school students' cognitive level lowest average score is in C4 evaluating (37), C5 creating (41.1), and C6 Analyzing (43.5)

consecutively. Thus, both university and senior high school students' have low High Order Thinking skills (C4-C6 cognitive level). The study's findings indicate that students' LA are relatively poor. These results indicate that HOT is more difficult for pupils to grasp than LOT, and its promotion necessitates greater teacher attention (Raiyn & Tilchin, 2015; Yuliati & Lestari, 2018).

Relationship Between Critical Thinking Skills and Creative Thinking Skills

The correlation between CriTS and CreTS in this study is in accordance with that of Kamaei (2013) that said both critical and creative thinking abilities are important and related skills for students in today's age. It is in accordance with the findings of this research that demonstrates a favourable and substantial connection between critical and creative thinking skills. There is a correlation between senior high school students' CriTS and CreTS, with the significance (All: β=.4, ϱ<.01; Male: β=.397, ϱ<.05; Female: β=.395, ϱ<.01) and the regression equation is significant (All: F=15.84, p<.01; Male: F=6.179, p<.05; Female: F=8.863, p<.01). There is a correlation between university students' CriTS and CreTS, with the significance (All: β=.619, ϱ<.01; Male: β=.643, ϱ<.05; Female: β=.609, ϱ<.01) and the regression equation is significant (All: F=48.335, p<.01; Male: F=7.044, p<.05; Female: F=38.85, p<.01).

Thus, regardless of gender (male: ϱ<.05, female: ϱ<.05) or education level (senior high school: ϱ<.05, university: ϱ<.05), a student with excellent CriTS most likely will also have good CreTS. When an individual analyzes critically, he or she can transform knowledge creatively, according to Schafersman (1991). According to Ülger (2016), critical thinking cannot be separated from creative thinking in terms of thinking abilities.

The regression equation describing the relationship between CriTS and CreTS for high school students is Y = 35.4 + .32 and for university students is Y = 24.95 + .52. According to the findings, the value of CreTS for senior high school students without account for CriTS is 35.4, and the value of CreTS rises by .32 for each additional point of CriTS. Furthermore, the value of CreTS for university students without account for CriTS is 24.95, and the value of CreTS rises by .52 for each additional point of CriTS.

Results on figure 1 indicated the magnitude of the path coefficient of every predictor variable. University students' CriTS make the highest contribution to their CreTS with a path coefficient of .619, ϱ<.05 than senior high school students' CriTS contribute to their CreTS with a path coefficient of .4, ϱ<.05. Based on gender, university male students' CriTS have the highest contribution to their CreTS with a path coefficient of .643, ϱ<.05 (cf. 0.609, ϱ<.05 for females). Senior high school male students' CriTS also has the highest contribution to their CreTS with a path coefficient of .397, ϱ<.05 (cf. females at 0.395, ϱ<.05). The samples in this research were selected from high school and university students who majored in natural science.

Relationship Between Critical Thinking Skills and Learning Achievement

The relation between CriTS and LA in this research is in agreement with that of Gharzakili (2014), Jufrina (2016), Kamaei (2013), Nami (2014), Taghva (2014), Wan (2018), who stated there is a significant and positive relationship between CriTS and LA. Attempts to improve students' CriTS are also indirect efforts to improve student LA, as indicated by Caroselli (2009), Kariasa (2014), Sari (2017), and who all stated that CriTS had a positive impact on LA. Identifying and solving issues, expressing hypotheses from varied basic information, drawing conclusions, and other activities to train CriTS may also train student LA.

The result of this research shows there is no difference between male and female (male: ϱ<.05, female: ϱ<.05) and between senior high school students and university students (senior high school: ϱ<.05, university: ϱ<.05) in terms of the positive and significant relationship between CriTS and LA. Thus, regardless of gender or education level, a student with excellent CriTS most likely will also have good LA.

The regression equation describing the relationship between CriTS and LA for high school students is Y = 17.5 + .69 and for university students is Y = 23.11 + .61. According to the findings, the value of LA for senior high school students without account for CriTS is 17.5, and the value of LA rises by .69 for each additional point of CriTS. Furthermore, the value of LA for university students without accounting for CriTS is 23.11, and the value of LA rises by .61 for each additional point of CriTS.

Results on figure 1 indicated the magnitude of the path coefficient of every predictor variable. Senior high school students' CriTS make the highest contribution to their LA with a path coefficient of .57, ϱ<.05 than university students' CriTS contribute to their LA with a path coefficient of .376, ϱ<.05. Based on gender, university male students' CriTS have the highest contribution to their LA with a path coefficient of .585, ϱ<.05 (cf. 0.356, ϱ<.05 for females). Senior high school female students' CriTS has the highest contribution to their LA with a path coefficient of .618, ϱ<.05 (cf. males at 0.496, ϱ<.05).

Relationship Between Creative Thinking Skills and Learning Achievement

The relation between CreTS and LA in this research is in agreement with that of Anwar (2017), Herlina (2017), Nuriadin (2013), Nursofah (2018), Vasudevan (2013), who stated there is a significant and positive relationship between CreTS and LA. Efforts to improve students' CreTS are also indirect efforts to improve student LA. This research is also similar to that of Nuriadin (2013) and Sari (2017), which stated that CreTS have a positive contribution to LA. Ishaq (2013) found that CreTS have 31.2% contribution to LA. Beneficial abilities that exist in CreTS, such as flexibility, help students obtain good LA.

The result of this research shows that there is no difference between male and female (male: ϱ<.05, female: ϱ<.05) and between senior high school students and university students (senior high school: ϱ<.05, university: ϱ<.05) in terms of the positive and significant relationship between CreTS and LA. Thus, regardless of gender or education level, a student with excellent CreTS most likely will also have good LA.

The regression equation describing the relationship between CreTS and LA for high school students is Y = 8.62 + .86 and for university students is Y = 1.76 + 1.02. According to the findings, the value of LA for senior high school students without account for CreTS is 8.62, and the value of LA rises by .86 for each additional point of CreTS. Furthermore, the value of LA for university students without account for CreTS is 1.76, and the value of LA rises by 1.02 for each additional point of CreTS. Senior high school students' CriTS have the highest contribution to their LA with a path coefficient of .57 (cf. 0.37 for university students). Based on gender, university male students' CriTS have the highest contribution to their LA with a path coefficient 0.585 (cf 0.356 for females).

Results on figure 1 indicated the magnitude of the path coefficient of every predictor variable. Senior high school students' CreTS make the highest contribution to their LA with a path coefficient of .562, ϱ<.05 than university students' CreTS contribute to their LA with a path coefficient of .528, ϱ<.05. Based on gender, university male students' CreTS have the highest contribution to their LA with a path coefficient of .588, ϱ<.05 (cf. 0.521, ϱ<.05 for females). Senior high school male students' CreTS has the highest contribution to their LA with a path coefficient of .573, ϱ<.05 (cf. females at 0.55, ϱ<.05).

Conclusion and Implications

With reference to the study's first research question (What are the levels of students' critical thinking skills, creative thinking skills, and learning achievement at Tebing Tinggi senior high school and Jember state Islamic institute?), it is concluded that Tebing Tinggi senior high school and Jember state Islamic institute students' critical and creative thinking skills are at the basic level and students' learning achievement are at the fair level. With regard to the study's second research questions (Does the level of education and gender of students at Tebing Tinggi senior high school and Jember state Islamic institute influence the relationship between critical and creative thinking skills and learning achievement?), the result are in line with many previous studies. Critical thinking abilities of senior

high school and university students have a significant impact on creative thinking skills and learning achievement in both genders. There are also noteworthy effects of senior high school and university students' creative thinking skills on learning achievement in both sexes.

Numerous publications offer and empirically test strategies for enhancing students' CriTS. One strategy is by using a variety of innovative learning models, including reasoning (Kuek, 2010), 7E (Yuberti et al., 2019), and blended learning (Hasanah, 2020). Other strategies include developing critical thinking throughout the learning process (Hidayati, 2019), incorporating learning material into the learning process (Twiningsih, 2021), and so on. Numerous articles also describe and experimentally evaluate methods for improving pupils' CreTS. One approach is to use a range of learning models, such as problem based learning (Nuswowati, 2015) and creative problem-solving exercises (De bono, 2007). Additional methods include developing creative thinking throughout the application of technology (Price et al, 2009), implementation of laboratory-based creative thinking and critical thinking (Koray & Koksal, 2009), and so on. Additional research is strongly needed to ascertain the reasons for this research sample's low level of creative cognitive skills, since the purpose of this study is limited to defining the profile of students' CreTS without examining the causes in depth and accurately.

Future research may be conducted to examine the correlation between critical thinking skills, creative thinking skills, and learning achievement by extending and/or moderating the relationship via the incorporation of external variables and/or the use of different demographic samples. Also, the current research was conducted only in Tebing Tinggi and Jember, two major cities in Indonesia. It is unknown to what degree the findings apply to other cities' schools or institutions. As a result of this study, it is recommended that the findings should be validated via comparable research conducted at other schools or institutions in Indonesia.

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