journal homepage: https://ojs3.unpatti.ac.id/index.php/biopendix

B I O P E N D I X P-ISSN: 2407-4969
Volume 12, Number 2, October 2025 E-ISSN:2684-8341
Pages: 143-153 DOI: https://doi.org/10.30598/biopendixvol12issue2page143-153

The Correlation between Critical and Creative Thinking Skills to Learning Outcomes in Cell and Tissue Materials

Nur Aisyah Ainun[1*], Arsad Bahri[2], Andi Asmawati Azis[3]

Biology Education, Faculty of Mathematics and Natural Science, State University of Makassar, Makassar, Indonesia
*email: nur.aisyah.ainun@unm.ac.id

Submitted: July 12, 2025; Revised: August 02, 2025; Accepted: August 15, 2025; Published: October 31, 2025

Abstract. Optimizing student competence begins with empowering fundamental skills, namely critical and creative thinking skills. This study aims to investigate the correlation between critical thinking skills and creative thinking skills simultaneously on cognitive learning outcomes of 162 students in grades XI and XII who have learned cell and tissue material at the Movement School in Biringkanaya District, Makassar City in the even school year 2022/2023. Research data were collected using integrated essay questions as many as 10 items that were valid (4.73) and reliable (0.853). The data obtained from the research sample in the form of quantitative data will be analyzed with two kinds of analysis techniques, namely descriptive analysis and inferential analysis. The results of statistical inferential analysis showed a correlation between critical thinking skills, creative thinking skills, and cognitive learning outcomes of students in movement schools on cell and tissue material (=0.730, <0.001, N= 162). The correlation is positive with a regression equation $\hat{Y}$= 7.796 + 0.322X1 + 0.402X2 with an effective contribution of 53.26%. Therefore, learning needs to empowering critical and creative thinking skills to support the optimization of students in facing the challenges of everyday life problem.

Keywords: Cell and Tissue Materials; Cognitive Learning Outcomes; Creative Thinking Skills; Critical Thinking Skills; Movement School

Copyright © 2025 to Authors

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution ShareAlike 4.0 International License

How to cite this article:
Ainun, N. A., Bahri, A., & Azis, A. A. (2025). The Correlation between Critical and Creative Thinking Skills to Learning Outcomes in Cell and Tissue Materials. BIOPENDIX: Jurnal Biologi, Pendidikan Dan Terapan, 12(2), 143 - 153. https://doi.org/10.30598/biopendixvol12issue2page143-153

Journal homepage: https://ojs3.unpatti.ac.id/index.php/biopendix
Journal e-mail: jbiopendix@gmail.com
Research Article: Open Access

INTRODUCTION

Low student cognitive learning results are the result of inadequate support for high-level thinking competencies, particularly critical and creative thinking in Indonesian 21st-century education. Due to this issue, Indonesia's poor educational standards are affected (Kurniawati, 2022; Masbullah & Bahri, 2022), despite the fact that the 21st century demands highly skilled human resources, critical and creative thinking is one of the most important cognitive abilities since it can inspire people to constantly approach problems critically and come up with novel solutions, leading to the creation of something new which is better for him and advantageous to his life (Mursidah et al., 2019; Rashidov, 2020). Cognitive capacities are a sign of a successful increase in human resources within the education sector (Rini & Budijastuti, 2022; Utami et al., 2020). Movement School resulting in changes to raise the standard of education in Indonesia (Sakdiah et al., 2023; Satriawan et al., 2021). The level of education provided in schools must be balanced with good character and is not dependent on student intelligence or the IQ of the younger generation. Aspects of critical and creative reasoning are highlighted in the Pancasila student profile (Mariana, 2021). Previous research has discussed the thinking skill.

Previous research has discussed critical thinking skills and creative thinking skills, but there are still very limited studies that discuss the correlation between these two abilities and cognitive learning outcomes. Both skills are fundamental in facing the challenges of daily life problems, especially regarding living things

consisting of trillions of cells (Kilag et al., 2023; Levin, 2021; Oktafiani et al., 2025). Cell and tissue material covers the basic concepts of how cells and tissues interact in organisms. Cells and tissues are basic material and have characteristics related to students' daily lives and are considered the right material to be implemented to stimulate critical thinking skills, so that they are able to understand and develop more complex concepts (Hikmawati & Ningsih, 2020; Ng et al., 2022). The need for understanding basic concepts is because in learning, each concept is related to other concepts (Adhani & Rupa, 2020; Puspitasari et al., 2019; Supena et al., 2021). A thorough understanding of concepts can realize meaningful learning.

Meaningful learning can improve student learning achievement, especially thinking skills. Critical and creative thinking skills invite students to play an active and effective role in solving the problems faced (Maulina et al., 2022; Prihatin et al., 2022). In addition, the transferable skills that students acquire during the learning process can be used in the real world, providing them with the ability to address challenging environmental and social issues (Bahri et al., 2021; Mahanal et al., 2019; Pilu et al., 2025). Learning expects students to participate more actively so as to improve their ability to think critically and creatively. High-level thinking skills are part of the Higher Order Thinking Skills (HOTS) which are certainly needed by students to face the next era of education (Ramadhana et al., 2022). Students' creative thinking skills cannot be obtained instantly but require a process and need to be trained or optimally empowered (Listiana & Bahri, 2019; Siburian et al., 2019).

Based on this rationality, it is very necessary to conduct research that examines thinking skills, especially critical and creative thinking skills. The purpose of this study is to investigate the correlation between critical thinking skills and creative thinking skills simultaneously on cognitive learning outcomes in cell and tissue material at the Movement School in Biringkanaya District, Makassar. So that it is expected to optimize students' critical and creative thinking skills effectively.

MATERIALS AND METHODS

The type of research that will be used in this study is research ex post facto which is correlational in nature. This means that this study only examines an event without any prior treatment of the object to be studied (Alhassan et al., 2021; Kusuma et al., 2021; Nomleni, 2023) to investigate the correlation between critical thinking skills and creative thinking skills (independent variable) with biological cognitive learning outcomes (variable dependent. The participants in this study were 162 students in grades XI and XII who have learned cell and tissue material at the Movement School in Biringkanaya District, Makassar City in the even school year 2022/2023. The sampling technique is using purposive random sampling, with representation of each high school based on the category of Movement School (applying a prototype of the new paradigm curriculum).

The instruments used in this study were 10 items of integrated essay test questions, critical thinking skills, creative thinking skills, and learning outcomes of the cell and tissue subject matter. The instruments that have been validated and rated for their validity and reliability. There are two types of validity tests, namely the expert validity test assessed by two expert lecturers on material and instruments with a value of 4.73 and empirical validity test with a value of 0.328-0.743, besides the coach reliability value of 0.853 (high).

Critical thinking skills indicators suggested by Ennis, (1993) namely providing elementary clarification, basic support, interfence, advanced clarification, and managing strategies and tactics. While creative thinking skills suggest by Munandar, (2016) which includes fluency, flexibility, originality, and elaboration. Additonally, operational verbs of cognitive learning outcomes based on revised bloom's taxonomy (Anderson & Krathwohl, 2017) in the C4-C6 domain.

The rubric rates critical thinking skill adapted from Zubaidah et al., (2020) on a scale 0-5 while creative thinking skill scoring rubric employed a 0-4 point scale, which is modified from. To assess cognitive learning outcomes in cell and tissue material using score by a rubric that refers to Hart (1994) on a scale of 0-4.

Data analysis was carried out with two kinds of analysis techniques, namely descriptive analysis and inferential analysis. Analyzed descriptively using Microsoft Excel 2019. Before conducting inferential statistical tests, prerequisite analysis tests were first carried out which consisted of 4 tests, namely normality, linearity, heteroscedasticity, and multicollinearity tests. Hypothesis testing includes simple and multiple linear regression tests to find the magnitude of the correlation and contribution of two independent variables to the dependent variable using SPSS 25 for windows software. All results of inferential statistical analysis have a standard significance value (sig.) > 0.05.

RESULTS AND DISCUSSION

The descriptive analysis result of critical thinking skills are presented in Table 1. Data on critical thinking skills is in the medium category with a percentage of 67.90% with frequency 110 students, while a lowest category is very low was 3.09% with frequency 5 students.

Table 1. Category, Frequency, and Percentage of Critical Thinking Skills of School Students Mobilizing on Cell and Tissue Material in Biringkanaya District, Makassar City

Percentage Score Interval	Category	Frequency	Percentage (%)
$81.25 < X \leq 100$	Very High	16	9,88
$71.50 < X \leq 81.25$	Tall	22	13,58
$62.50 < X \leq 71.50$	Keep	110	67,90
$43.75 < X \leq 62.50$	Low	9	5,56
$0 < X \leq 43.75$	Very Low	5	3,09

The average percentage of critical thinking skills indicators is 67.31% in Table 2. The highest percentage of student answers was the indicator of managing strategies and tactics which was 71.91%, while the lowest analysis result was the aspect interfence which was 63.21%.

Table 2. Percentage of Achievement of Critical Thinking Skills Indicators of Movement School Students on Cell and Tissue Material in Biringkanaya District, Makassar City

Critical Thinking Skills Indicators	Percentage (%)
Elementary clarification	68,21
Build basic support skills	65,74
Interfence	63,21
Provide advanced clarification	67,47
Strategies & tactics	71,91
Average	**67,31**

The indicator of organizing strategies and tactics is in 2 items, namely in number 4 and 9. Item 4 with the editorial question about nerve cells, this question directs students to provide answers about how to maintain nerve cells in everyday life. Meanwhile, item 9 is about how to increase the mass of hand muscle tissue. This is in accordance with the results of research conducted (Hidayati & Indriana, 2022; Pertiwi et al., 2021), that the high indicator of organizing strategies and tactics is because students already know a lot about how to maintain healthy nerve cells and how to form strong skeletal muscle tissue through various sources such as the internet, textbooks, and their own experiences. While creative thinking skills are in the medium category with a percentage of 50.62% with a frequency of 82 students in Table 3, then the lowest creative thinking skills data is in the very low category with a percentage of 0%.

Table 3. Category, Frequency, and Percentage of Creative Thinking Skills of Mobilizing School Students in Biringkanaya District, Makassar City

Percentage Score Interval	Category	Frequency	Percentage (%)
$80 < X \leq 100$	Very High	37	22,84
$60 < X \leq 80$	Tall	40	24,69
$40 < X \leq 60$	Keep	82	50,62
$20 < X \leq 40$	Low	3	1,85
$0 < X \leq 20$	Very Low	0	0

The average percentage indicator of creative thinking skills is 65.12% in Table 4. The highest percentage of student answers is found in the first indicator, namely the fluency indicator with a value of 67.28%, while the lowest analysis results are found in the fourth indicator, namely the Elaboration indicator with a value of 62.73%.

Table 4. Percentage of Achievement of Creative Thinking Skills Indicators of School Students Mobilizing Cell and Tissue Materials in Biringkanaya District, Makassar City

Creative Thinking Skills Indicators	Percentage (%)
Fluency	67,28
Flexibility	65,17
Originality	65,28
Elaboration	62,73

Average	**65,12**

Based on the analysis of aspects of indicators of students' creative thinking skills, it is known from 4 aspects of creative thinking skills that the aspect that has the highest percentage is the fluency aspect, which is 67.28%. This is according to the results of research that has been conducted (Agustiana et al., 2020; Yolanda, Mahardika, & Wicaksono, 2021; Cahyani, Martini, & Purnomo, 2022) which states that the fluency aspect shows the highest percentage of scores, this is because the learning process is fun and varied.

An example of the question used to measure the participants critical thinking skills on item 1 regarding the differences between animal cells and plant cells by presenting a discourse on the causes of differences in the structure of plant stems and ear leaves. The indicators that are expected to be achieved by students are to come up with many ideas, many answers, many problem solutions, many questions fluently (Aisyah et al., 2023; Handayani et al., 2021).

One of the principles in the Movement School is differentiated problem-based learning. So, students are given challenges or problems that they have to solve. This activity leads students to think critically and creatively to find effective solutions (Kardoyo et al., 2020; Mulyani et al., 2023). In addition, at the Movement School, there is always room for students to explore and express their ideas especially through projects at the end of the semester. This is important to support the development of students' critical and creative thinking. So that they have the freedom to try new things and dare to express their ideas, their thinking skills will definitely be more developed and honed (Azis & Mu'nisa, 2021; Setyani et al., 2023).

The normality test is a data test that aims to find out whether the residural value is normally distributed or not. Data normality testing of critical thinking skills variables (X_1) and creative thinking skills (X_2), and cognitive learning outcomes variables (Y) were conducted using the Kolmogrov-smirnov test with the SPSS 25 for *windows* program. The results of the data normality test are described in Table 5.

Table 5. Normality Test Results with Kolmogrov-Smirnov

		Unstandardized Residual
N		162
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	7.55469896
Test Statistic		.079
Exact Sig. (2-tailed)		.248

The SPSS output results are known that the research data has a probability value of Sig. which is greater than the probability of 0.05 or (Sig = 0.05) which is 0.248 0.05 $\alpha =>$ $\alpha >$. So it can be concluded that the research data comes from normally distributed data. The linerity test aims to determine whether two variables have a linear correlation or not significantly. The results of the linearity test with the help of the SPSS program version 25.0 for windows can be seen in Table 6.

Table 6. Linearity Test Results

Model Korelasi	**N**	**Alpha (*α*)**	***Sig.(2-tailed)***
X_1 with Y	162	0,05	0,415
X_2 with Y	162	0,05	0,786

That the results of the linearity test through the SPSS program version 25.0 for windows obtained the value of Sig. between variables X_1 and Y which is 0.415, for the correlation between variables X_2 and Y which is 0.786 . The correlation model of the two independent variables (X_1 &; X_2) is greater than the probability level $\alpha = 0.05$ or (Sig. > $\alpha = 0.05$), so it can be concluded that critical thinking skills and creative thinking skills with learning outcomes are linear.

The heteroscedasticity test is used to determine the presence or absence of classical asusmsi abnormalities, heteroscedasticity, namely the presence of variance inequality from residuals for all observations in the correlation model. To prove this can be done with the Glejser test. The glacier test values can be seen in Table 7.

Table 7. Heteroskedasticity Test Results

Variable	**Say.**	**Information**
Critical Thinking Skills	0,688	No heteroscedasticity occurs
Creative Thinking Skills	0,247	No heteroscedasticity occurs

That the significance value (Sig.) for the critical thinking skill variable (X_1) is 0.688. Meanwhile, the significance value (Sig.) for the creative thinking skill variable (X_2) is 0.247. Because the significance value of the two independent variables is greater than 0.05, it corresponds to the basis of decision making in the glejser heteroscedasticity test. So it can be concluded that the data do not occur symptoms of heteroscedasticity.

The multicollinearity test is used to determine whether or not there is a strong correlation between independent variables and correlation. The basis for decision making if there are no symptoms of multicollinearity, if the tolerance value > 0.100 and the VIF value < 10.00. The results of the multicollinaras test can be seen in Table 8.

Table 8. Test Results of Multicolinearity

Variable	Collinearity Statistics		Information
	Tolerance	BRIGHT	
Critical Thinking Skills	0,488	2,049	No multicollinearity occurs
Creative Thinking Skills	0,488	2,049	No multicollinearity occurs

That the Tolerance value> 0.100 and the VIF value < 10.00 for all variables. So it can be concluded that there is no storage of the correlation between the independent variable and the correlation model or there is no symptom of rhythmiculceration. Because the data has met the requirements, simple and multiple regression tests can be carried out.

Table 9. Regression of the Correlation between Critical Thinking Skills and Cognitive Learning Outcomes of School Students Mobilizing Cell and Tissue Material in Biringkanaya District, Makassar City

Model	R	R Square
1	.645[a]	.415

Based on Table 9 above, it is known that critical thinking skills contribute 41.5% in explaining the achievement of student learning outcomes. Another meaning of the results of this analysis is that 58.5% is explained by other r-factos besides critical thinking skills. Based on the value of the correlation coefficient (R), also know the correlation between critical thinking skills and learning outcomes is in the medium category. The regression coefficient value b = 0.704 and the constant value a = 5.391. Thus the regression equation is obtained which is $\hat{Y} = 5.391 + 0.704X_1$. Therefore, the regression equation can explain and draw further conclusions about the correlation between critical thinking skills and cognitive learning outcomes of Movement School Students on Cell and Tissue Material in Biringkanaya District, Makassar City which is depicted with a simple linear regression line in Figure 1.

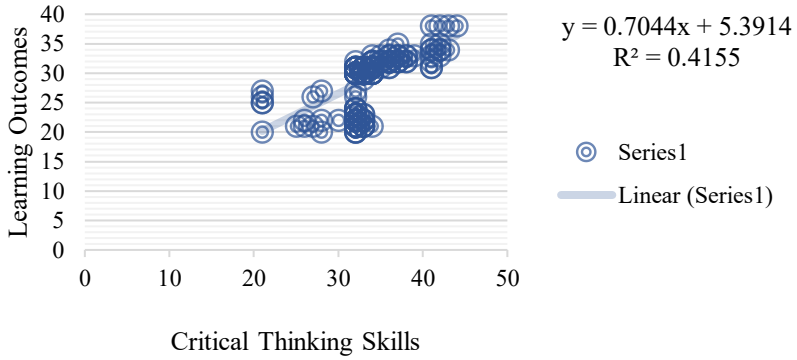


Figure 1. Graph of the Correlation between Critical Thinking Skills and Cognitive Learning Outcomes of School Students Mobilizing Cell and Tissue Material in Biringkanaya District, Makassar City

Cell material, plant tissue structure and function, and animal tissue structure and function are able to stimulate critical thinking skills (Fitroh et al., 2022; Ng et al., 2020). This is despite the fact that learning biology materials such as cells and evolution contain complex and abstract content (Fajarianingtyas & Hidayat, 2023; Sari et al., 2023; Sitohang et al., 2025). This is relevant to some of the research results reported (Annisa et al., 2020; Cahyono & Dwikoranto, 2021; Megati et al., 2021; Nurhasnawati et al., 2023; Supena et al., 2021; Tuaputty et al., 2021), which states that there is a positive correlation between critical thinking skills and student learning outcomes, which means that the higher the level of critical thinking skills of students, the greater the significant functional correlation to cognitive learning outcomes, and also the greater the contribution or contribution of critical thinking skills to the cognitive learning outcomes obtained by students. The results of the regression

analysis were conducted to explain the correlation between creative thinking skills and cognitive learning outcomes of students at the Movement School of Biringkanaya District, Makassar City. The results of the regression analysis are described in Table 10.

Table 10. Regression of the Correlation between Creative Thinking Skills and Cognitive Learning Outcomes of School Students Mobilizing Cell and Tissue Material in Biringkanaya District, Makassar City

Model	R	R Square
1	.700[a]	.490

The results of data analysis with variance analysis tests are aimed at finding out whether predictors can predict criterium significantly. A summary of the results of the variance analysis test is shown in Table 11.

Table 11. Analysis of Variance in the Correlation between Creative Thinking Skills and Cognitive Learning Outcomes of School Students Mobilizing Cell and Tissue Material in Biringkanaya District, Makassar City

Model	Free degree	Average Sum of Squares	Sig.
1 Regresi	1	1541.250	.000[b]
Remainder	160	10.020	
Total	161		

From Table 11 it is known that the probability value of $\alpha = 0.05$ is greater than the probability value of Sig. which is 0.000, thus it can be concluded that creative thinking skills are able to predict the achievement of student learning outcomes. This means that creative thinking skills have a significant correlation with the achievement of student learning outcomes. The results of the analysis of the regression equation coefficient between creative thinking skills (X_2) and cognitive learning outcomes (Y) are shown.

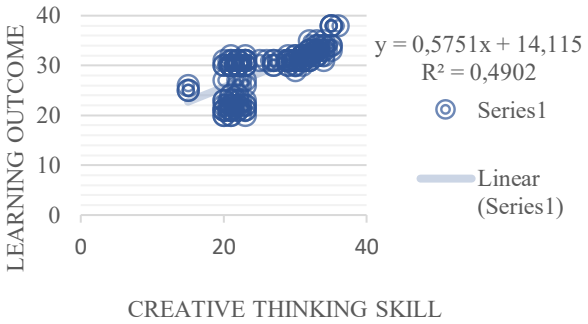


Figure 2. Graph of the Correlation between Creative Thinking and Cognitive Learning Outcomes of School Students Mobilizing Cell and Tissue Material in Biringkanaya District, Makassar City

Figure 2 shows that the graph of a simple linear regression equation is $\hat{Y} = 14.115 + 0.575X\,2$ whichmeans: (1) if the thinking skills creative (X2) = 0 then the cognitive learning outcomes of students (Y) can be estimated at 14.115 and (2) if there is a change in thinking skills creative (X_2) by one unit, the learning outcome can be estimated at 0.575 at the constant unit 14.115. The results of a simple regression analysis are known that it shows that the higher the level of creative thinking skills of students, the higher the learning outcomes. The findings in this study also reject H_0 and accept H_1 which states "there is a correlation between thinking skills and cognitive learning outcomes of Movement School students on cell and tissue material in Biringkanaya District, Makassar City".

Cell and tissue material is challenging for students to optimize creative thinking. One example of a problem that measure students' creative thinking skills in the originality indicator found in item number 8 which directs students to associate the phenomenon of skin cancer with the structure of epithelial tissue. It is expected that students can provide their arguments based on assumptions and knowledge gained while studying cells and tissues. This is relevant to some of the research results reported (Rauf, Halim & Mahmud, 2020); (Samudera, 2020); (Febriyanti & Wulandari, 2021) Balance the thinking structure participants learn as meaningful learning outcomes obtained through cognitive processes (Haris, 2022).

Table 12. Regression of the Correlation between Creative Thinking Skills and Cognitive Learning Outcomes of School Students Mobilizing Cell and Tissue Material in Biringkanaya District, Makassar City

Model	R	R Square
1	.730[a]	.532

Based on Table 12 above, it is explains that critical thinking skills and creative thinking skills contribute 53.20% in explaining the achievement of student learning outcomes. Another meaning of the results of this analysis is that 46.80% is explained by other facto r in addition to critical thinking skills and creative thinking skills. Based on the value of the correlation coefficient (R), also know the correlation between critical thinking skills and creative thinking skills with learning outcomes being in the medium category. The results of data analysis with variance analysis tests are aimed at finding out whether predictors can predict criterium significantly. A summary of the results of the variance analysis test is shown in Table 13.

Table 13. Analysis of Variance in the Correlation between Critical Thinking Skills and Creative Thinking Skills with Cognitive Learning Outcomes of School Students Mobilizing Cell and Tissue Material in Biringkanaya District, Makassar City

	Model	Free Degrees	Average Sum of Squares	Sig.
1	Regresi	2	837.104	.000[b]
	Remainder	159	9.247	
	Total	161		

From Table 13 it is known that the probability value of α = 0.05 is greater than the probability value of Sig. which is 0.000, thus it can be concluded that critical thinking skills and creative thinking skills are able to predict the achievement of student learning outcomes. This means that critical thinking skills and creative thinking skills have a significant correlation with the achievement of student learning outcomes. The results of the analysis of the coefficient of regression equation between critical thinking skills (X_1) and creative thinking skills (X_2) with cognitive learning outcomes (Y) are shown in Table 14.

Table 14. Coefficient of Regression Equation the Correlation between Critical Thinking Skills and Critical Thinking Skills with Cognitive Learning Outcomes of School Students Drive on Cell and Tissue Material in Biringkanaya District, Makassar City

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Konstanta)	7.796	2.045		3.813	.000
	Critical Thinking Skills	.322	.085	.294	3.792	.000
	Creative Thinking Skills	.402	.064	.490	6.307	.000

Based on Table 14 above, the regression coefficient $b_1 = 0.322$, $b_2 = 0.402$ and the constant a = 7.796. Thus, the regression equation is $\hat{Y} = 7.796 + 0.322X_1 + 0.402X_2$. The results of a simple regression analysis are known that it shows that the higher the level of critical thinking skills and creative thinking skills of students, the higher the learning outcomes. The findings in this study also reject H_0 and accept H_1 which states "there is a correlation between critical thinking skills and creative thinking skills together with the cognitive learning outcomes of Movement School students on cell and tissue material in Biringkanaya District, Makassar City".

Table 15. Effective Contribution between Critical Thinking Skills and Critical Thinking Skills with Cognitive Learning Outcomes of Movement School Students on Cell and Tissue Material in Biringkanaya District Makassar City

Variable	Regression Coefficient (Beta)	Correlation Coefficient (r)	Effective Contribution
Critical Thinking Skills	0,294	0,645	18,96
Creative Thinking Skills	0,490	0,700	34,30
	Sum		53,26

From Table 15. it is known that the largest effective contribution to the dependent variable (learning outcomes) is given by creative thinking skills, which is 34.30%, and critical thinking skills are 18.96%. The total effective contribution of the two independent variables amounted to 53.26%, which means critical thinking skills and creative thinking skills, together made an effective contribution of 53.26% to the Cognitive Learning Outcomes of Movement School Students on Cell and Tissue Material in Biringkanaya District, Makassar City, while 46.74% was influenced by factors that were not studied.

This positive correlation can be interpreted that the higher the critical thinking skills of students, the higher the creative thinking skills of students and will affect the improvement of cognitive learning outcomes of students. This is in line with the results of research that has been found by (Fatmawati et al., 2019; Siburian, Corebima, Ibrohim, et al., 2019) which states that there is a significant positive correlation between critical thinking skills, creative thinking skills that contribute greatly to improving students' cognitive learning

outcomes. Thus, it is necessary to empower thinking skills in learning to further improve critical and creative thinking skills, as well as learning outcomes by using innovative learning so as to improve the quality of learning for the better.

CONCLUSION

Critical thinking skills and creative thinking skills of Movement School students on cell and tissue material in Biringkanaya District, Makasaar City are in the medium category. The cognitive learning outcomes of Movement School students on cell and tissue material in Biringkanaya District, Makasaar City are in the sufficient category.There is positive and significant correlation between critical thinking skills and the cognitive learning outcomes of students who are at the level of median correlation with a sig. value 0,000 less than α = 0,05. There is positive and significant correlation between creative thinking skills and the cognitive learning outcomes of students who are at an average level of correlation with a sig. value 0,000 less than α = 0,05. There are positive and meaningful correlation between critical thinking skills and creative thinking skills in conjunction with the cognitional learning outcomes of the learners who are on a medium level of relation with an sig. rating 0,000 less than α = 0,05.

ACKNOWLEDGEMENTS

Thank you to the unit head, teachers, and students of SMA Islam Al-akhyar Makassar, SMAS Buq'atun Mubarakah, and SMAS Plus Budi Utomo Makassar.

REFERENCES

Adhani, A., & Rupa, D. (2020). Analisis Pemahaman Konsep Mahasiswa Pendidikan Biologi pada Matakuliah Fisiologi Tumbuhan. *Quantum: Jurnal Inovasi Pendidikan Sains*, *11*(1), 18. https://doi.org/10.20527/quantum.v11i1.8035

Agustiana, I. G. A. T., Agustini, R., Ibrahim, M., & Tika, I. N. (2020). Efektivitas Model OPPEMEI untuk Meningkatkan Kemampuan Berpikir Kreatif Mahasiswa. *Journal of Education Technology*, *4*(2), Article 2. https://doi.org/10.23887/jet.v4i2.25343

Aisyah, A. N. I., Hasyim, M., & Jumriani, H. (2023). Penerapan Model Project Based Learning Berbantuan Media Canva Untuk Meningkatkan Kemampuan Berpikir Kreatif (Indikator Kelancaran) Peserta Didik. *Jurnal Pemikiran dan Pengembangan Pembelajaran*, *5*(2), Article 2. https://doi.org/10.31970/pendidikan.v5i2.749

Alhassan, I., Islam, K. M. A., & Haque, M. S. (2021). Sustainability Reporting and Financial Performance of Listed Industrial Goods Sector in Nigeria. *International Journal of Accounting & Finance Review*, *9*(1), 46–56. https://doi.org/10.46281/ijafr.v9i1.1541

Anderson, & Krathwohl. (2017). *Kerangka Landasan untuk Pembelajaran, pengajaran, dan Asesmen Revisi Taksonomi Pendidikan Bloom (2nd ed.)*. Pearson Education.

Annisa, L., Oktaviana, C., & Habibi, A. A. (2020). Hubungan Keterampilan Berpikir Kritis Dengan Hasil Belajar Peserta Didik. *Edubiologica Jurnal Penelitian Ilmu Dan Pendidikan Biologi*, *8*(1), 35–37.

Azis, A. A., & Mu'nisa, A. M. (2021). Peningkatan Motivasi, Aktivitas dan Hasil Belajar Biologi Melalui Penerapan Teknik Mind Mapping pada Materi Sistem Ekskresi Siswa Kelas XI IPA B SMA Negeri 2 Sengkang. *Science Education and Learning Journal*, *1*(2 (Novembe), 42–56.

Bahri, A. (2016). Strategi Pembelajaran Reading Questioning and Answering (RQA) pada Perkuliahan Fisiologi Hewan untuk Meningkatkan Hasil Belajar Kognitif Mahasiswa. *BIONATURE 'Jurnal Kajian, Penelitian, Dan Pengajaran Biologi'*, *17*(2).

Bahri, A., Abrar, A., & Arifin, A. N. (2021). Needs Analysis of Development Higher Order Thinking Skills-based E-module for Students High School. *Indonesian Journal of Educational Studies*, *24*(1), 72–79.

Cahyani, E. R., Martini, M., & Purnomo, A. R. (2022). Analisis Kemampuan Berpikir Kreatif Siswa SMP terhadap Konsep Pencemaran Lingkungan Ditinjau dari Perbedaan Gender. *PENSA: E-JURNAL PENDIDIKAN SAINS*, *10*(1).

Cahyono, B. D. T., & Dwikoranto, D. (2021). Implementasi Model Pembelajaran Problem Based Learning untuk Meningkatkan Kemampuan Berfikir Kritis pada Siswa. *IPF : Inovasi Pendidikan Fisika*, *10*(1), 1–7.

Ennis, R. H. (1993). Critical Thinking Assessment. *Theory Into Practice*, *32*(3), 179–186. https://doi.org/10.1080/00405849309543594

Fajarianingtyas, D. A., & Hidayat, J. N. (2023). Pengembangan Media Pembelajaran Berbasis Web Biologi Dasar untuk Meningkatkan Kemampuan Pemecahan Masalah Mahasiswa IPA. *Jurnal Kiprah*, *11*(1), Article 1. https://doi.org/10.31629/kiprah.v11i1.5357

Fatmawati, A., Zubaidah, S., Mahanal, S., & Sutopo. (2019). Critical Thinking, Creative Thinking, and Learning Achievement: How They are Related. *Journal of Physics: Conference Series*, *1417*(1), 012070. https://doi.org/10.1088/1742-6596/1417/1/012070

Febriyanti, S. A., & Wulandari, F. (2021). Hubungan Berpikir Kreatif Melalui Model Mind Mapping dengan Hasil Belajar Siswa Sekolah Dasar. *PEDAGOGIKA*, *1*(2), 152–160. https://doi.org/10.37411/pedagogika.v12i2.871

Fitroh, A., Azis, A. A., & Marliyah, S. (2022). Analisis Penerapan Model Pembelajaran Problem Based Learning dalam Mengerjakan LKPD Materi Struktur dan Fungsi Tumbuhan. *Jurnal Profesi Kependidikan*, *3*(1 Apr), Article 1 Apr. https://ojs.unm.ac.id/JPK/article/view/27515

Handayani, S. A., Rahayu, Y. S., & Agustini, R. (2021). Students' Creative Thinking Skills in Biology Learning: Fluency, Flexibility, Originality, and Elaboration. *Journal of Physics: Conference Series*, *1747*(1), 012040. https://doi.org/10.1088/1742-6596/1747/1/012040

Haris, A. (2022). Proses Kognitif Dalam Desain Pembelajaran Berbasis Masalah. *JISIP (Jurnal Ilmu Sosial Dan Pendidikan)*, *6*(1), Article 1. https://doi.org/10.58258/jisip.v6i1.2820

Hart, D. (1994). *Authentic Assessment: A Handbook for Educators. Assessment Bookshelf Series.* Dale Seymour Publications, 10 Bank Street, White Plains, NY 10602. Tel: 800-872-1100 (Toll Free). https://eric.ed.gov/?id=ED447179

Hidayati, N., & Indriana, L. (2022). Critical Thinking Skills Student of Class XI SMAN 4 Pekanbaru in learning Biology TA.2020/2021. *Biology and Education Journal*, *2*(1), Article 1. https://doi.org/10.25299/baej.2022.9915

Hikmawati, V. Y., & Ningsih, Y. S. (2020). Blended-Problem Based Learning: Critical Thinking Skills and Information Literacy in Cell Learning. *Jurnal BIOEDUKATIKA*, *8*(2), Article 2. https://doi.org/10.26555/bioedukatika.v8i2.14315

Kardoyo, Nurkhin, A., Muhsin, & Pramusinto, H. (2020). Problem-Based Learning Strategy: Its Impact on Students' Critical and Creative Thinking Skills. *European Journal of Educational Research*, *9*(3), 1141–1150. https://doi.org/doi: 10.12973/eu-jer.9.3.1141

Kilag, O. K., Miñoza, J., Comighud, E., Amontos, C., Damos, M., & Abendan, C. F. (2023). Empowering Teachers: Integrating Technology into Livelihood Education for a Digital Future. *Excellencia: International Multi-Disciplinary Journal of Education (2994-9521)*, *1*(1).

Kurniawati, F. N. A. (2022). Meninjau Permasalahan Rendahnya Kualitas Pendidikan di Indonesia dan Solusi. *Academy of Education Journal*, *13*(1), Article 1. https://doi.org/10.47200/aoej.v13i1.765

Kusuma, A. S., Nisa, K., & Baskara, Z. W. (2021). Trend Penelitian Skripsi Mahasiswa PGSD Universitas Mataram di Masa Pandemi Covid-19. *Jurnal Ilmiah Profesi Pendidikan*, *6*(3), Article 3. https://doi.org/10.29303/jipp.v6i3.196

Levin, M. (2021). Life, Death, and Self: Fundamental Questions of Primitive Cognition Viewed Through The Lens of Body Plasticity and Synthetic Organisms. *Biochemical and Biophysical Research Communications*, *564*, 114–133. https://doi.org/10.1016/j.bbrc.2020.10.077

Listiana, L., & Bahri, A. (2019). Empowering Student's Creative Thinking Skill in Biology Classroom: Potential of Group Investigation Combined with Think Talk Write (GITTW) Strategy. *Humanities & Social Sciences Reviews*, *7*(3).

Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A Learning Model to Develop Critical Thinking Skills for Students with Different Academic Abilities. *International Journal of Instruction*, *12*(2), 417–434.

Maison, M., Ernawati, M. D. W., Budiarti, R. S., Kurniawan, Y., Okta, W., Ningsih, Y., Puspitasari, T. O., Jannah, N., & Putra, D. S. (2019). Learning In Nature Science: Social Implications, Normality Of Scientist, Attitudes Towards Investigation Of Natural Science, And Interest Adds To Science Learning Time. *International Journal of Scientific & Technology Research*, *8*(12), 1478–1484.

Mariana, D. (2021). *Pengaruh Kepemimpinan Kepala Sekolah Terhadap Efektivitas Sekolah Penggerak dalam Meningkatkan Kualitas Pendidikan*. *5*.

Masbullah, & Bahri, S. Y. (2022). Analisis Analisis Perencanaan Sumber Daya Manusia (SDM) Dalam Peningkatan Mutu Pendidikan Di Sma Muhammadiyah Selong. *MAMEN: Jurnal Manajemen*, *1*(1), Article 1. https://doi.org/10.55123/mamen.v1i1.26

Maulina, D., Aini, V., Yolida, B., & Marpaung, R. R. T. (2022). Guided Inquiry Model Assisted HOTS-Based Worksheet for Critical Thinking Ability in Online Learning During Pandemic Covid-19. *Jurnal BIOEDUKATIKA*, *10*(1), Article 1. https://doi.org/10.26555/bioedukatika.v10i1.21532

Megati, A., Prasetyo, E., Gleko, G., & Wungukung, O. (2021). Hubungan Kemampuan Berpikir Kritis Terhadap Hasil Belajar Siswa Kelas X IPA Pada Materi Reaksi Redoks Di SMA Negeri 1 Talibura. *CHEMUR*, *4*(1), Article 1.

Mulyani, S., Nurmeta, I. K., & Maula, L. H. (2023). Analisis Implementasi Profil Pelajar Pancasila di Sekolah Dasar. *Jurnal Educatio FKIP UNMA*, *9*(4), Article 4. https://doi.org/10.31949/educatio.v9i4.5515

Munandar, U. (2016). *Pengembangan Kreativitas Anak Berbakat*. Rineka Cipta. http://repo.iainbatusangkar.ac.id/xmlui/handle/123456789/3950

Mursid, R. (2019). *The Effect of Learning Model Based on Higher Order Thinking Skills (HOTS) with Multimedia and Creative Thinking Abilities on Learning Outcomes of Vocational Learning Design*. 1–5. https://www.atlantis-press.com/proceedings/aisteel-19/125931943

Mursidah, S., Susilo, H., & Corebima, A. D. (2019). Hubungan antara Keterampilan Berpikir Kritis dan Keterampilan Berkomunikasi dengan Retensi Siswa dalam Pembelajaran Biologi melalui Strategi Pembelajaran Reading Practicing Questioning Summarizing and Sharing. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, *4*(8), Article 8. https://doi.org/10.17977/jptpp.v4i8.12676

Ng, P. M. L., Chan, J. K. Y., & Lit, K. K. (2022). Student learning performance in online collaborative learning. *Education and Information Technologies*, *27*(6), 8129–8145. https://doi.org/10.1007/s10639-022-10923-x

Ng, W. L., Chan, A., Ong, Y. S., & Chua, C. K. (2020). Deep Learning for Fabrication and Maturation of 3D Bioprinted Tissues and Organs. *Virtual and Physical Prototyping*, *15*(3), 340–358. https://doi.org/10.1080/17452759.2020.1771741

Nomleni, R. (2023). The Correlation of Social Environment Toward Children's Learning Achievement at SMA PGRI Kupang. *SocioEdu: Sociological Education*, *4*(1), 16–20. https://doi.org/10.59098/socioedu.v4i1.871

Nurhasnawati, N., Suhertina, S., Herlinda, F., Arisanti, D., Murny, M., & Martius, M. (2023). Kontribusi Kemampuan Berpikir Kritis dan Ketertarikan Keagamaan terhadap Hasil Belajar Agama Islam. *JPPI (Jurnal Penelitian Pendidikan Indonesia)*, *9*(1), 12–17. https://doi.org/: https://doi.org/10.29210/ 189900

Oktafiani, R., Febriyana, A., Haka, N. B., & Kesumawardani, A. D. (2025). Pengaruh Model Pembelajaran Problem Based Learning Berbantu Media Augmented Reality untuk Meningkatkan Higher Order Thinking Skill Kelas XI Pada Meteri Sel di SMAN 1 Abung Selatan Lampung Utara. *BIOPENDIX: Jurnal Biologi, Pendidikan Dan Terapan*, *11*(2), Article 2. https://doi.org/10.30598/biopendixvol11issue2page144-148

Pertiwi, D. A., Hidayat, M., & Rasmi, D. P. (2021). Identifikasi Tingkat Kemampuan Berpikir Kritis Siswa pada Materi Fluida Statis. *Jurnal Pendidikan Fisika Tadulako Online*, *9*(1), 57–62.

Pilu, R. O. U., Makaborang, Y., & Ndjoeroemon, Y. (2025). Penggunaan Metode Peta Konsep Ditambah dengan Media Leaflet untuk Meningkatkan Kualitas Pembelajaran Siswa Kelas IX di SMP Negeri 1 Kambera. *BIOPENDIX: Jurnal Biologi, Pendidikan Dan Terapan*, *11*(2), Article 2. https://doi.org/10.30598/biopendixvol11issue2page243-249

Prihatin, A. I., Komala, R., Ristanto, R. H., & Saifuddin, M. F. (2022). Relationship of Metacognitive Skills, Critical Thinking, and Students' Knowledge of Ecosystem Concepts. *Jurnal BIOEDUKATIKA*, *10*(2), Article 2. https://doi.org/10.26555/bioedukatika.v10i2.23397

Puspitasari, Y., Reza, S. P. K., Bachtiar, Y., & Prayitno, B. A. (2019). Identifikasi Miskonsepsi Materi Jaringan Tumbuhan pada Mahasiswa Pendidikan Biologi di Salah Satu Universitas di Surakarta. *BIOEDUKASI: Jurnal Pendidikan Biologi*, *10*(2), Article 2. https://doi.org/10.24127/bioedukasi.v10i2.2494

Ramadhana, F., Adnan, A., & Azis, A. A. (2022). Uji Validitas Pengembangan E-LKPD Berorientasi Hots Materi Sistem Pernapasan Sma Kelas Xi. *KROMATIN : Jurnal Biologi Dan Pendidikan Biologi*, *3*(1), Article 1. https://journal.unismuh.ac.id/index.php/kromatin/article/view/8917

Rashidov, A. (2020). *Development of Creative and Working with Information Competences of Students in Mathematics*. *8*(3).

Rauf, J., Halim, S. N. H., & Mahmud, R. S. (2020). Pengaruh Kemampuan Berpikir Divergen dan Kemandirian Belajar terhadap Hasil Belajar Matematika Siswa. *Mandalika Mathematics and Educations Journal*, *2*(1), 1–9. https://doi.org/10.29303/jm.v2i1.1776

Rini, A. F., & Budijastuti, W. (2022). Pengembangan Instrumen Soal Hots untuk Mengukur Keterampilan Pemecahan Masalah pada Materi Sistem Gerak Manusia. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *11*(1), 127–137. https://doi.org/10.26740/bioedu.v11n1.p127-137

Sakdiah, H., Rahimi, A., Darlis, A., Ammar, S. A., & Daulay, D. A. (2023). Sekolah Penggerak Sebagai Upaya Peningkatan Kualitas Pendidikan. *Jurnal Pendidikan Dan Konseling (JPDK)*, *5*(1), Article 1. https://doi.org/10.31004/jpdk.v5i1.11012

Samudera, W. (2020). Pengaruh Gender Terhadap Kemampuan Berpikir Kreatif Peserta Didik SMA di Kota Mataram. *Indonesian Journal of Teacher Education*, *1*(2), 87–92.

Sari, D. N., Ningsih, K., & Wahyuni, E. S. (2023). Kelayakan LKPD Berbasis Inkuiri Terbimbing untuk Melatihkan Keterampilan Proses Sains pada Materi Sistem Organisasi Kehidupan. *Bioscientist : Jurnal Ilmiah Biologi*, *11*(2), 1385–1399. https://doi.org/10.33394/bioscientist.v11i2.9286

Satriawan, W., Santika, I. D., & Naim, A. (2021). Guru Penggerak Dan Transformasi Sekolah Dalam Kerangka Inkuiri Apresiatif. *Al-Idarah : Jurnal Kependidikan Islam*, *11*(1), Article 1. https://doi.org/10.24042/alidarah.v11i1.7633

Setyani, A. I., Putri, D. K., Pramesti, R. A., Suryani, S., & Ningrum, W. F. (2023). Pembelajaran Biologi dalam Kurikulum Merdeka di Sekolah Urban. *DIAJAR: Jurnal Pendidikan Dan Pembelajaran*, *2*(2), Article 2. https://doi.org/10.54259/diajar.v2i2.1364

Siburian, J., Corebima, A. D., İbrohim, İ., & Saptasari, M. (2019). The Correlation Between Critical and Creative Thinking Skills on Cognitive Learning Results. *Eurasian Journal of Educational Research*, *19*(81), Article 81. https://doi.org/10.14689/ejer.2019.81.6

Sitohang, M. S., Putri, W. N., Sueng, Y., Tarigan, R. S. B., Pasaribu, C. E., Mukra, R., & Arwita, W. (2025). Analysis of Biology Learning Resources and Materials in PJBL, PBL, and Deep Learning in Class X in Biology Teachers and Students of SMA Negeri 2 Lubuk Pakam. *BIOPENDIX: Jurnal Biologi, Pendidikan Dan Terapan*, *12*(1), Article 1. https://doi.org/10.30598/biopendixvol12issue1page16-24

Supena, I., Darmuki, A., & Hariyadi, A. (2021a). The Influence of 4C (Constructive, Critical, Creativity, Collaborative) Learning Model on Students' Learning Outcomes. *International Journal of Instruction*, *14*(3), 873–892. https://doi.org/10.29333/iji.2021.14351a

Supena, I., Darmuki, A., & Hariyadi, A. (2021b). The Influence of 4C (Constructive, Critical, Creativity, Collaborative) Learning Model on Students' Learning Outcomes. *International Journal of Instruction*, *14*(3), 873–892.

Tuaputty, H., Leasa, M., Corebima, A. D., & Batlolona, J. R. (2021). The Correlation between Critical Thinking Skills and Cognitive Learning Outcomes. *İlköğretim Online*, *20*(1), 302–317. https://doi.org/10.17051/ilkonline.2021.01.029

Utami, S. W., Sunandar, A., & Kurniawan, A. D. (2020). Application of Two Problem Solving Cycles to Students' Higher-Order Thinking Skills on Reproductive System Material. *Journal of Biological Education Indonesia (Jurnal Pendidikan Biologi Indonesia)*, *6*(3), 383–388.

Yolanda, S. B., Mahardika, I. K., & Wicaksono, I. (2021). Penggunaan Media Video Sparkol terhadap Kemampuan Berpikir Kreatif Siswa pada Pembelajaran IPA di SMP. *Jurnal Pendidikan Fisika*, *9*(2), Article 2. https://doi.org/10.24127/jpf.v9i2.3780

Zubaidah, S., Mahanal, S., Mistianah, & Fauzi, A. (2020). *Critical Thinking Embedded Essay Test*. 171–177. https://doi.org/10.2991/absr.k.200807.036