VOLUME 7 No 2
JULY 2022

E-ISSN: 2622-3384
P-ISSN: 2527-9939

JURNAL MEdu Mangifera Edu

On the relationship between critical thinking skills, biology learning outcomes, and their visual learning style

Witri Noor Ayu, Purwati Kuswarini Suprapto*, Vita Meylani
Department of Biology Education, Faculty of Teacher Training and Education, Universitas Siliwangi,
Jl. Siliwangi No.24 Kota Tasikmalaya, West Java, Indonesia
Corresponding author: *purwatikuswarini@unsil.ac.id

ABSTRACT

Critical thinking ability refers to an individual's capacity for in-depth thought due to the development of diverse thinking talents, including cognitive capabilities, in response to the acquired information. The purpose of the present study was to investigate the relationship between critical thinking skills, biology learning outcomes, and the visual learning style of students. The study used the correlational research method to ascertain the association between critical thinking abilities and biology learning outcomes among students with a visual learning style in class XI MIPA SMAN 6 Tasikmalaya. To this end, 40 students with predominating visual learning styles were selected from 137 students from class XI MIPA 4-7 at SMAN 6 Tasikmalaya. They were asked to fill in a learning style questionnaire with 23 statements. Moreover, they were asked to answer the nine-question evaluation of students' critical thinking abilities regarding biology topics. Students completed learning outcomes from the Year-End Assessment (PAT) grade XI MIPA in biological issues. Pearson product-moment correlation was employed to answer the research question. The result of the study indicated there is critical thinking ability had a limited association with learning outcomes in students who chose a visual learning approach. The correlation coefficient (R) of 0.365 and coefficient of determination (R2) of 0.133 attested to this. The findings revealed that both critical thinking skills and visual learning styles could predict learning outcomes.

ARTICLE INFO

Keywords
Biology Learning, Critical Thinking, Learning Outcomes, Visual Learning Style

Received
January 17, 2022

Revised
April 18, 2022

Accepted
May 18, 2022

Published
July 31, 2022

How to cite
Ayu, W. N., Suprapto, P. K., & Meylani, V. (2022). On the relationship between critical thinking skills, biology learning outcome, and their visual learning style. *Jurnal Mangifera Edu*, 7(1), 22-32. https://doi.org/10.31943/mangiferaedu.v7i1.137

INTRODUCTION

The rapid advancement of science has affected the passage of several parts of education, where education is critical to a nation's progress. It is because of a nation's human resources by the quality of its education (Setiana & Purwoko, 2020). It can improve human resources in educational institutions, such as schools, where students are engaged in a learning process. The term "current student learning" relates to twenty-first-century education. The twenty-first-century learning process places a premium on the concept of critical thinking, which all components, including teachers and students, must possess (Mite & Corebima, 2017). Critical thinking must become a pervasive element of the educational experiences of all students from pre-school to upper high school and university (Aizikovitsh-Udi & Cheng, 2015). Critical thinking is an active intellectual

process that entails the acquisition of abilities in comprehending and applying concepts and analyzing, synthesizing, and evaluating. Derived these abilities through experience that is used to analyze arguments and provide interpretations based on rational perceptions, assumption analysis, and logical interpretation (Supena et al., 2021).

Based on the pre-introduction sending some questions to students via a google form determined that most students had never worked on critical thinking skills related to biology material. Additionally, students still struggled to analyze problems in biology material, as evidenced by some students' inability to provide opinions or ideas during the learning process. It is because students believe they do not understand the material. As a result, students' critical thinking abilities have not yet developed, and critical thinking plays a crucial role in the learning process. Because critical thinking is a process of using cognitive skills and strategies to increase the likelihood of achieving goals by incorporating various skills in problem-solving, formulating inferences, calculating possibilities, and so on (Halpern, 2013). This statement is related to several parts of critical thinking skills and learning outcomes. Which includes cognitive talents such as indicators of analyzing, evaluating, and generating based on Bloom's taxonomy revision theories (Nugroho, 2018). Thus, developing critical thinking skills affects cognitive knowledge, which involves student learning outcomes.

Numerous factors can affect student learning results. According to Mite & Corebima (2017), various variables influence student learning outcomes, including learning styles, critical thinking abilities, metacognitive abilities, and learning models. As a result, along with necessary thinking abilities, learning style is a factor that might influence learning results. Their preferred learning style is their preferred method of absorbing, organizing, and processing information (Bire et al., 2014). They were classifying learning styles into visual, auditory, and kinesthetic. Each student processes information differently, resulting in unequal grasping power; some students prefer to process information visually by viewing pictures, watching videos, reading books, or listening to teacher explanations. Others prefer to process information physically, such as through practicum activities.

According to interviews with biology topic teachers, only conducted explanation and discussion activities after each content discussion using virtual zoom media during the online biology learning process. The online learning process is supported by providing instructional videos, modules, and topic assignments via school-provided applications. Based on the online learning, it will be visual, with each module having a visual component in the form of writing and images. So that their sense of sight dominates students' ability to absorb and process information, a preliminary study indicates that most pupils have a more dominant visual learning style. Thus, the author wishes to ascertain students' critical thinking abilities who choose a visual learning style.

Critical thinking abilities are required when studying biology. Students can use the nature of biology through thinking critically to construct and comprehend concepts, principles, facts, and solutions to biological problems (Azubuike & David, 2015). Biological material concerns abstract concepts or objects, such as chemical metabiosis processes occurring within the body and hormonal systems, particularly the reproductive system. Depending on the distribution of the material, it may

be required to include visual elements such as photographs, graphics, concept maps, diagrams, or videos. The visual side of learning biology relates to students' visual learning styles, allowing them to readily absorb and digest information with their eyes developing students' critical thinking abilities, which can alter and improve student learning results.

Nurdiana (2021), found a good correlation between critical thinking skills and physics learning outcomes for students in class XI MIA SMA Negeri 2 Pangkep for visual learning styles, with critical thinking skills having a 93.7 percent effect on learning outcomes. Amin et al. (2020), also demonstrate a significant correlation between critical thinking and metacognitive skill in animal physiology lectures. So, critical thinking is the most advanced cognitive talent that enables successful issue solving (Fitriani et al., 2020). They considered the importance of critical thinking skills as components of higher-order thinking skills for developing students' abilities and understanding of biology concepts. Previous research show that few studies have revealed the relationship between critical thinking skills and student biology learning outcomes with visual learning styles. The present study aims to determine whether there is a relationship between critical thinking skills and biology learning outcomes in visual learning style students. The implication is that teachers can train the critical thinking skills of students who have a visual learning style to improve student learning outcomes.

METHOD

The research approach employed in this study is non-experimental quantitative research with a correlational focus. According to Mills & Gay (2019), correlation research entails the collection of data to ascertain the existence and degree of the link between two or more measurable variables. This research conducted in SMA Negeri 6 Tasikmalaya in September 2021. The population studied in this research is the entire XI MIPA class at SMA Negeri 6 Tasikmalaya for the academic year 2020/2021. There were four classes totaling 137 students. Purposive sampling was used, with samples drawn from students with a predominance of visual learning styles, 40 students. The instrument employed in this study is a questionnaire on learning styles and a test of critical thinking abilities on even semester XI biology material. All instruments are in the valid and reliable categories.

The research procedure was conducted in several steps. Firstly, studies preliminary by the researcher with a meaning look for the reference to determine the problem for identifying it. The initial data is obtained about the problem and a description of the identification problem will be researched. Secondly, the researcher prepares all tool research, including instrument research. Validity and reliability testing revealed that the instrument learning style questionnaire contained 23 valid statements. The critical thinking ability exam had nine valid description questions and reliability tall based on criteria reliability that can be seen in Table 1.

The instrument questionnaire style study is based on DePorter & Hernacki's classification of three learning styles and indicators: visual, audio, and kinesthetic (Peng, 2002). The guidelines score questionnaire is based on the scale Likert, which can be seen in Table 2. Meanwhile, developing the critical thinking ability instrument using (Ennis, 1985) indications include offering

simple explanations, developing fundamental abilities, inferring, providing additional answers, and developing strategies and tactics. Student learning outcomes were determined using documentation of biology PAT results in class XI during the even semester of the 2020/2021 Academic Year.

Table 1. Instrument reliability testing criteria

No	Reliability	Information
1	r ≤ 0.20	Very low reliability
2	0.20 < r ≤ 0.40	Low reliability
3	0.40 < r ≤ 0.70	Medium reliability
4	0.70 < r ≤ 0.90	High reliability
5	0.90 < r ≤ 1.00	Very high reliability

Source: Guilford in (Rosita et al., 2021)

Table 2. Guidelines score statement questionnaire

Statement	Score Positive	Score Negative
Very Agree (SS)	4	1
Agree (S)	3	2
Not enough Agree (KS)	2	3
No Agree (TS)	1	4

The third is providing research instruments on students online via Google Forms. Fourthly, the data obtained in the field then data processing for knowability think critical and results in study biology on the student with visual learning style. Data analysis uses investigation precondition and testing hypothesis. Analysis precondition covers test normality using Kolmogorov-Smirnov, and the linearity test uses the test for linearity with a significance level of 5%. To examine the hypothesis test uses the Pearson bivariate correlation test. Additionally, the T-test was used to analyze the regression equation (Independent T-test). SPSS 26 for Windows was used to conduct the overall data analysis.

RESULTS AND DISCUSSION

The following table summarizes the findings of research on the relationship between critical thinking skills and biology learning outcomes:

Table 3. Critical thinking ability and biology learning outcomes statistics

No	Statistik	Critical Thinking Ability Score	Study Results Score
1.	Minimum score	10	64
2.	Maximum score	23	93
3.	Average	16.4	83.1
4.	Median	17	83.5
5.	Mode	17	88
6.	Standard deviation	3.3	6.4
7.	Variance	11.2	41.2

Source: Result of data processing with SPSS 26 for windows

Table 3 contains statistical data on the critical thinking abilities of students with a visuallearning style. The research data was evaluated using the preconditioning test and hypothesis testing. The prerequisite tests are the normality and linearity tests with Kolmogorov Smirnov. Examine the hypothesis using the Pearson correlation test. Moreover, if the findings indicated a relationship, a subsequent test, namely a basic regression test, was used to determine the effect of one variable on other variables. All precondition and hypothesis tests were conducted by using SPSS 26 for Windows at a 5% significance level. The data collected in this study results from a correlation between critical thinking abilities and learning outcomes. The complete data set is available in the following table.

Table 4. Summary of normality test

No	Data	(α)	Significance	Results Analysis	Conclusion Analysis
1.	Critical thinking ability	0.05	0.070	Significance > 0.05	Ho accepted
2.	Result Study	0.05	0.200	Significance > 0.05	Ho accepted

Source: Result of data processing with SPSS 26 for windows

According to Table 4. the normality test results indicate a significant value of 0.070 for critical thinking skills and 0.200 for learning outcomes. Both sets of data have a significance level greater than 0.05. As a result, both data sets are consistent with a regularly distributed population. After confirming that the data is normal, followed the preconditioning by a linearity test. The following table summarizes the linearity test:

Table 5. Summary of linearity test results

No	Data	(α)	Significance	Results Analysis	Conclusion Analysis
1.	Learning outcomes* Critical thinking skills	0.05	0.818	Significance > 0.05	Ho accepted

Source: Result of data processing with SPSS 26 for windows

According to the data in Table 5. the significant value of critical thinking with learning outcomes is 0.818, more significant than 0.05. This data indicates that critical thinking skills are linear with learning outcomes. In addition, using the bivariate correlation to continue the test. Table 6 contains the findings of the bivariate correlation test.

Table 6. Summarizes the results of the bivariate correlation test.

Model Summary								
Model	***R***	***R Square***	***Adjusted R square***	***Std Error of the Estimate***	***F change***	**df 1**	**df 2**	
1	0.365[a]	0.133	0.110	6.05227	5.833	1	38	0.021

a. Predictors: (Constant), Critical Thinking
b. Dependent Variable: Learning Outcome

Source: Result of data processing with SPSS 26 for windows

Table 6 shows the calculation of the correlation coefficient (R) of 0.365 and coefficient of determination (R2) of 0.133. Thus, critical thinking ability contributes 13.3% to learning outcomes, while the remaining variables in this study were not evaluated.

Table 7 shows that the regression equation is Y= a+bx. The value for a is 71.669, rounded to 71.67, and the b value for x is 0.699, rounded to 0.7. As a result, the regression equation Y= 71.67+0.7x was obtained. Table 5 shows demonstrate a beneficial association between critical thinking and learning abilities. Figure 1 shows the link between critical thinking skills and learning outcomes derived from the regression equation.

Table 7. A synopsis of the T test

Model		*Unstandardized Coefficient*		*Standardized Coefficient*	T	Sig.
		B	*Std. Error*	*Beta*		
1	(Constant)	71.669	4.829		14.842	0.000
	Critical Thinking	0.699	0.289	0.365	2.415	0.021

a. Dependent Variabel: Learning outcomes

Source: Results of data processing with SPSS 26 for windows

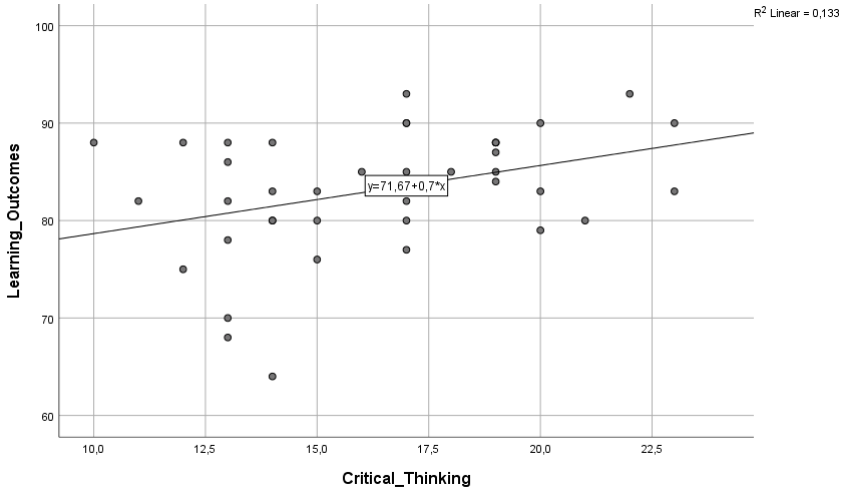

Figure 1. Scatter plot graph of critical thinking ability with learning outcomes

The scatter plot graph in Figure 1 demonstrates a linear relationship between critical thinking abilities and students' biology learning outcomes when they use visual learning approaches. Y= 71.67+0.7x is the regression equation derived. The regression equation indicates that the value of a is 71.67 and the value of b is 0.7. The points represent the error value or data from a linear connection in the scatter plot graph. This positive association implies that their biology learning result improves when students' critical thinking abilities develop.

1) Correlation between Critical Thinking Ability and Academic Achievement

The bivariate correlation test result was obtained using SPSS 26 for window. There is a positive and significant relationship between critical thinking skills and the biology learning outcomes of visual learning style students in Class XI MIPA SMAN 6 Tasikmalaya, as indicated by a significance value less than 5% significance level of 0.021 0.05, then the hypothesis is rejected. Additionally, the correlation coefficient (R) is 0.365, indicating a low degree of the link between variables, and the coefficient of determination is 0.133, or 13.3%.

According to the findings of this study, there is a positive relationship between critical thinking skills and biology learning outcomes in visual learning style students. This finding is consistent with Nurdiana, (2021) results, who discovered a positive relationship between critical

thinking skills and students' physics learning outcomes in visual learning styles. And vital. Roswati et al. (2019), there show a significant positive association between critical thinking skills and student learning outcomes, contributing 38.2 percent. A significant association between students' critical thinking abilities and student biology learning results indicates that focusing on critical thinking skill development is vital to improving student learning outcomes. According to Mustofa (2019), associated critical thinking abilities and learning outcomes, the more excellent the critical thinking skills of students, the higher their learning outcomes.

The low correlation between these variables indicates that the critical thinking abilities of visual learning style students are not evenly distributed, amonge some students. They still needed training and redevelopment, given that they conducted the learning process online. This resulted in some students were unfamiliar with the material delivered online. In addition, trained students do not have to engage in critical thinking practices.

2) Critical Thinking Ability

According to Ennis, based on research conducted in class XI MIPA 4–7 SMAN 6 Tasikmalaya, students' critical thinking skills were measured using an instrument that containing nine essay questions based on critical thinking indicators. The questions are divided into several indicators: one question that provides a simple explanation, three questions that help build fundamental skills, two questions about conclusion, two questions about indicators that require further explanation, and one question setting strategies and tactics.

This study can determine the achievement of students' critical thinking skills by examining their responses to questions with varying scores on each indicator. We can find additional information in the schematic listed in Figure 2.

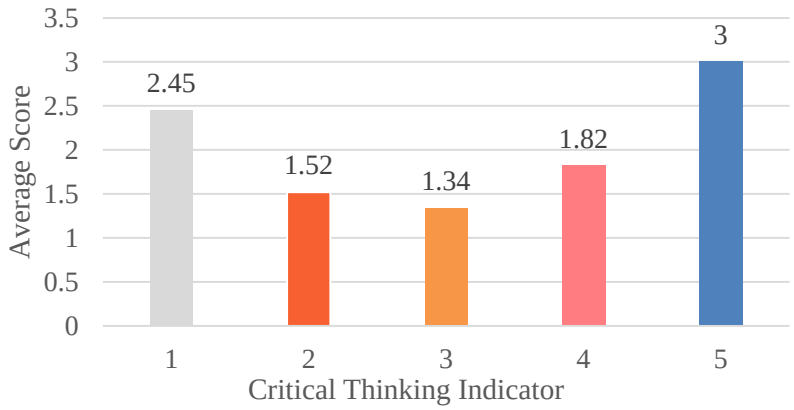

Figure 2. A diagram depicting the average score assigned to students' critical thinking abilities

Figure 2 depicts the average score for indications of critical thinking abilities for students with a visual learning style in class XI MIPA 4–7 SMAN 6 Tasikmalaya. According to the figure, the average score for indicator 1, which provides a simple explanation, is 2.45; for indicator 2, which focuses on developing fundamental skills, the average score is 1.52; for indicator 3, which provides inference, the average score is 1.34; and for indicator 4, it provides additional explanation. Additionally, it is 1.82, and indicator 5 to establish strategy and tactics is 3. Thus, the average score

for the most significant indicator of critical thinking ability is for setting strategy and tactics, while the indicator offering inference has the lowest score.

To obtain the highest average score on the indicator of setting strategies and tactics in the aspect of deciding on an action corresponds to Ramdan, (2015) that the indicators of critical thinking strategies and tactics in the aspect of choosing on an activity are the highest indicators when compared to other critical thinking indicators. As a result of this characteristic, kids with a visual learning style can strengthen their critical thinking skills. According to Muslimah et al. (2020) research, students with a visual learning style can work on questions pretty clearly and accurately in the sub-indicators of choosing an action. Students' learning experiences enable them to address difficulties through a variety of possible solutions. According to Prathiwi and Utami (2019), developing strategies and tactics for determining which actions or solutions to take involves the ability to think actively and constantly seek knowledge about a situation. Numerous activities, such as group conversations during the planning and performing of investigations, are believed to affect the development of critical thinking abilities on the sub-indicators of deciding an action.

While the indicator with the lowest average score provides inference, specifically on the sub-indicator used to make and consider judgments, this can occur due to students' lack of understanding of the difficulties stated in the questions. It is causing them to be less careful in reading and identifying the questions presented. According to Ennis (1995), when developing and considering a decision value based on facts, caution must be exercised, as the decision value must be capable of distinguishing between fact and fiction (Zahroh, 2020). The low indicator of critical thinking inference (inference) is consistent with the research (Fitriani&Irawan, 2018), indicating that students' critical thinking skills on indicators cause inference to receive the lowest score. It is because students cannot fully comprehend inference, interpret, recognize errors, and respond to alternative points of view.

3) Biology Learning Outcomes

The biology learning outcomes for students with visual learning styles were determined using the PAT (Year-End Assessment) documents for the even semester of class XI MIPA 4-7 SMAN 6 Tasikmalaya for the 2020/2021 academic year. Researchers categorize data on learning outcomes into three categories: high, medium, and low. They applied calculations to classify student learning outcomes, as shown in Table 5. Table 6 summarizes the results of the categorization of student learning outcomes.

Table 5. Categorization formula

Formula	Category
X > (M + 1 x SD)	High
(M-1 x SD) < X < (M + 1 x SD)	Currently
X < (M- 1x SD)	Low

According to Table 6 classified students who achieve high learning outcomes with a score of > 89 and a frequency of 6 as having high learning outcomes. Then, students who enter the medium group with a score of 76 <X <89 have a frequency of 29. Students who enter the low category with a

score of < 76 have a frequency of 5, the percentage of the category of depicted learning outcomes in Figure 3.

Table 6. Results of categorization of learning outcomes

Interval	Frequency	Percentage	Category
X > 89	6	15%	High
76 < X < 89	29	72.5 %	Currently
< 76	5	12.5%	Low

Results of Manual Data Processing

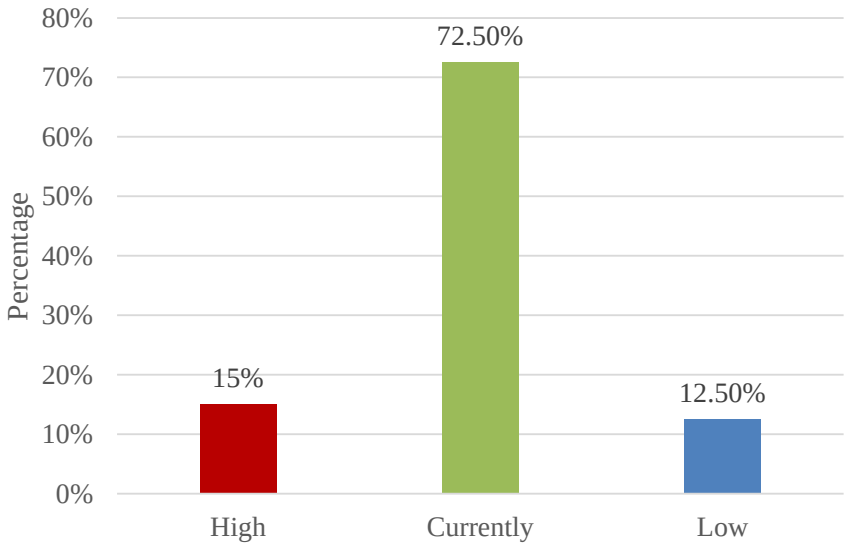

Figure 3. Learning outcomes bar chart

The percentage of results from the categorization of learning outcomes in Figure 3. 15% of students get high academic performance. Then, 72.5% of students fall into the middle category, while 12.5% fall into the poor category. The student demonstrated that learning results are satisfactory, as most student learning outcomes scores fall into the medium category.

CONCLUSION

From this study, it can be concluded that critical thinking ability significantly correlated with learning outcomes for students in class XI MIPA SMAN 6 Tasikmalaya who use the visual learning style. The indicating by a significance value smaller than the specified significance value of 0.021 < 0.05 and a correlation coefficient (R) of 0.365. As a result, critical thinking abilities contribute 13.3% to learning outcomes.

From the results of this study, we can improve student achievement by coaching and redeveloping students' critical thinking skills with teachers. It can also be done by incorporating various methods or strategies into the learning process that engages and enhances student experience to improve critical thinking skills. In addition, research is necessary to determine whether other elements are associated with and can increase critical thinking abilities and learning outcomes.

REFERENCES

Aizikovitsh-Udi, E., & Cheng, D. (2015). Developing critical thinking skills from dispositions to abilities: mathematics education from early childhood to high school. *Creative Education*, *6*(04), 455. https://doi.org/10.4236/ce.2015.64045

Amin, A. M., Corebima, A. D., Zubaidah, S., & Mahanal, S. (2020). The correlation between metacognitive skills and critical thinking skills at the implementation of four different learning strategies in animal physiology lectures. *European Journal of Educational Research*, *9*(1), 143–163. https://doi.org/10.12973/eu-jer.9.1.143

Azubuike, O., & David, S. (2015). Self-Directed Learning Strategy: A Tool for Promoting Critical Thinking and Problem Solving Skills among Social Studies Students. *IOSR Journal of VLSI and Signal Processing Ver. II*, *5*(3), 52–58. https://doi.org/10.9790/4200-05325258

Bire, A. L., Geradus, U., & Bire, J. (2014). Pengaruh gaya belajar visual, auditorial, dan kinestetik terhadap prestasi belajar siswa. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, *44*(2), 168–174. https://doi.org/10.21831/jk.v44i2.5307

Ennis, R. H. (1985). A logical basis for measuring critical thinking skills. *Educational Leadership*, *43*(2), 44–48.

Fitriani, A., Zubaidah, S., Susilo, H., & Al Muhdhar, M. H. I. (2020). The Correlation between Critical Thinking Skills and Academic Achievement in Biology through Problem Based Learning-Predict Observe Explain (PBLPOE). *International Journal of Learning and Teaching*, *6*(3), 170–176. https://doi.org/10.18178/ijlt.6.3.170-176

Fitriani, R. (2018). Peningkatan kemampuan berpikir kritis peserta didik SMP kelas VII melalui pembelajaran berbasis masalah. *Bioedusiana: Jurnal Pendidikan Biologi*, *3*(1), 8–14. https://doi.org/10.34289/277877

Halpern, D. F. (2013). Teaching for critical thinking: A four-part model to enhance thinking skills. In *The Teaching of Psychology* (pp. 111–126). Psychology Press.

Mills, G. E., & Gay, L. R. (2019). *Educational research: Competencies for analysis and applications*. ERIC.

Mite, Y., & Corebima, A. D. (2017). The correlation between critical thinking and the learning results of the senior high school students in biology learning implementing Group Investigation (GI) learning in Malang, Indonesia. *Journal of Applied and Advanced Research*, *2*(2), 56–62. https://doi.org/10.21839/jaar.2017.v2i2.57

Muslimah, A. I. (2020). Analisis berpikir kritis siswa SMP dalam menyelesaikan soal pecahan ditinjau dari gaya belajar. *KadikmA*, *11*(2), 50–62. https://doi.org/10.19184/kdma.v11i2.19806

Mustofa, R. (2019). Pengaruh Pembelajaran Learning Cycle 5e terhadap Kemampuan Berpikir Kritis dan Hasil Belajar. *Bioedusiana*, *4*(2), 51–58. https://doi.org/10.34289/277889

Nugroho, R. A. (2018). HOTS (Kemampuan Berpikir Tingkat Tinggi: Konsep, Pembelajaran, Penilaian, dan Soal-soal). *Jakarta: PT Gramedia Widiasarana Indonesia*.

Nurdiana, N. (2021). *Hubungan keterampilan berpikir kritis dengan hasil belajar fisika ditinjau dari gaya belajar peserta didik kelas XI MIA SMA Negeri 2 Pangkep*. Universitas Negeri Makassar. http://eprints.unm.ac.id/19374/

Peng, L. L. (2002). Applying learning style in instructional strategies. *CDTL Brief*, *5*(7), 1–3.

Prathiwi, A., & Utami, L. (2019). Analisis kemampuan berfikir kritis siswa menengah atas menggunakan model inquiry pictorial riddle. *Journal of The Indonesian Society of Integrated Chemistry (On Progress)*, *11*(2), 64–72. https://doi.org/10.22437/jisic.v11i2.7569

Ramdan, S. (2015). Peningkatan keterampilan berpikir kritis siswa SMP melalui penerapan levels of inquiry pada pembelajaran IPA terpadu. *Simposium Nasional Inovasi Dan Pembelajaran Sains*, 517–520.

Rosita, E., Hidayat, W., & Yuliani, W. (2021). Uji validitas dan reliabilitas kuesioner perilaku prososial. *FOKUS (Kajian Bimbingan & Konseling Dalam Pendidikan)*, *4*(4), 279–284.

https://doi.org/10.22460/fokus.v4i4.7413

Roswati, E., Hernawan, E., & Ardiansyah, R. (2019). Hubungan Keterampilan Berpikir Kritis Dengan Hasil Belajar Peserta Didik Pada Sub Konsep Psikotropika. *Prosiding Seminar Nasional Biologi Dan Pembelajarannya (SN-Biosfer)*, 262–268.

Setiana, D. S., & Purwoko, R. Y. (2020). Analisis kemampuan berpikir kritis ditinjau dari gaya belajar matematika siswa. *Jurnal Riset Pendidikan Matematika*, *7*(2), 163–177. https://doi.org/10.21831/jrpm.v7i2.34290

Supena, I., Darmuki, A., & Hariyadi, A. (2021). The influence of learning model on students' learning outcomes. *International Journal of Instruction*, *14*(3), 873–892. https://doi.org/10.29333/iji.2021.14351a

Zahroh, F. (2020). Pengaruh Model Pembelajaran Project Based Learning Terhadap Kemampuan Berpikir Kritis Siswa Pada Materi Elektrokimia. *Phenomenon: Jurnal Pendidikan MIPA*, *10*(2), 191–203. https://doi.org/10.21580/phen.2020.10.2.4283