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Exploring the Link Between Critical Thinking Styles and Students' Critical Thinking Ability in Biology Education

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ABSTRACT

Critical thinking style reflects how students apply their critical thinking skills, playing a crucial role in developing their overall ability to think critically. This study explores the relationship between high school students' critical thinking styles and their critical thinking abilities. The research involved 112 high school students who completed the YCCST instrument both as a pretest and posttest. Data were analyzed using correlation and regression tests, ensuring normal distribution (0.200 > 0.05) and linearity (0.277 > 0.05). The findings revealed a strong positive correlation (r = 0.714) between critical thinking styles and critical thinking ability. Regression analysis indicated that critical thinking style accounts for 51% of the variance in critical thinking ability. These results suggest that students' critical thinking styles significantly influence their ability to think critically. Educators can utilize this information by identifying students' thinking styles as a foundation for selecting appropriate teaching materials and learning methods, ultimately enhancing students' critical thinking skills. This study underscores the importance of assessing and incorporating students' thinking styles into educational practices to foster their critical thinking development. Future research could expand on these findings by exploring diverse educational settings and additional influencing factors.

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1. INTRODUCTION

Despite the growing focus on critical thinking ability in education, particularly in response to 21st-century challenges, the link between critical thinking styles and critical thinking ability has received less attention, especially in the field of biology learning. This research aims to address this gap by examining how effectively students' critical thinking styles predict their critical thinking skills in biology. Critical thinking style is a student's habitude to express and use their thinking abilities, while critical thinking ability are student's skills in using their thinking tendencies in analyzing, interpreting, applying, evaluating, and concluding.

Teachers have an important role in helping to prepare and develop students' critical thinking skills. (Yusnaeni et al., 2017) To achieve these goals, teachers are expected to always carry out contextual instruction innovations through the use of appropriate media, methods and learning strategies. This statement is supported by the expression (Samsudin & Hardini, 2019) that educators need to prepare for learning by considering the characteristics and learning needs of students in the digital era. One strategy that teachers can use before developing students' critical thinking ability is to know the students' critical thinking style. Jayanti (Syahfitri, 2023) explains that critical thinking style can determine the extent to which someone can use their critical thinking ability. In addition, it is also emphasized that critical thinking style and critical thinking ability are parts that determine each other. Riyan et al (Riyan Rizaldi et al., 2021), and Nuraffefa et al (Hamdan et al., 2021) state that each student expresses their thinking style in different ways according to their speed in acquiring and processing knowledge.

Several studies related to style have been conducted, such as research investigating critical thinking styles based on educational level, gender, academic achievement, and extracurricular activities (Syahfitri, 2023), (Abdi, 2012), (Wahyudi et al., 2023), and (Barrick & Dibenedetto, 2019). In addition, relevant research has also been investigated by Hamid et al. (Hamid et al., 2021), Peng et al. (Lu et al., 2021), and Lemuel et al. (Lemuel I, Perez, 2024) who analyzed thinking styles and how they impact self-efficacy and mathematical critical thinking skills. Based on this literature review, it can be concluded that there has been no research that specifically explores the link between critical thinking styles and students' critical thinking ability in biology.

Critical thinking abilities are active thinking abilities in processing knowledge, starting from conceptualizing, applying, synthesizing, analyzing, and evaluating information based on data obtained from observation, experience, and reasoning (David, 2019). Critical thinking skills refer to the art or style of a person's use of their thinking skills, which are influenced by experience factors in the learning environment (Murawski, 2022). Furthermore, Ken et al. (Changwong et al., 2018) added that critical thinking ability are a mental process that includes a person's habits in analyzing, synthesizing, and evaluating what they receive. Some of these explanations prove that critical thinking ability is related to how a person uses their thinking habits in everyday life.

Referring to the findings of the Programme for International Student Assessment (PISA) 2023, Indonesia improved its rank by five to six positions compared to PISA 2018. However, this progress was overshadowed by a decline of 12–13 points in reading, mathematics, and science scores (OECD, 2023). These results highlight the persistent challenges in developing 21st-century competencies among students, particularly their critical thinking abilities, which encompass problem analysis and solution formulation. The low level of high-order thinking skills among students reflects deficiencies in the quality of learning in schools. Current classroom practices show that enhancing high-order thinking skills, especially critical thinking, remains a low priority in educational objectives, particularly in science subjects.

Mahanal et al. (2016) emphasized that critical thinking, a key 21st-century competency, has not been adequately addressed in biology education. Similarly, Heard et al. (2020) identified critical thinking as an essential skill for students in the era of globalization but noted its lack of proper attention and support, making its development challenging. Munawarah et al. (2018) further confirmed that students still struggle to analyze and solve problems effectively. This gap is troubling, as critical thinking skills are crucial for navigating advancements in science and technology.

To address this issue, educators must adopt strategies to improve students' critical thinking skills, beginning with identifying and understanding their critical thinking styles. This need underscores the importance of investigating the relationship between thinking styles and critical thinking ability, particularly in biology education. This study seeks to answer the research question: To what extent can critical thinking styles predict students' critical thinking ability in biology?

2. METHODS

This study uses correlational analysis which is used to see the correlation between two variables, where the score of variable one can predict the score of variable 2, and regression analysis to assess the predictive power between variables (Santoso, 2021). This research purpose is to see to what extent students' critical thinking styles can predict students' critical thinking skills in biology.

Data collection began with a literature study and analysis of students' critical thinking styles. The study involved 112 students from three high schools in Bengkulu City by applying a simple random sampling technique. Data collection began by giving the Yanpiaw Creative-Critical Style Test (YCCST) instrument to students at the beginning of instruction to assess students' thinking styles. Furthermore, after students receive learning using research-based e-LKPD teaching materials, students are given a critical thinking skills test to assess their critical thinking ability. Research-based e-LKPD is a teaching material that has the characteristics and steps of research. Through research-based e-LKPD, can facilitate students in developing critical thinking ability, where students are trained to analyse and find solutions to existing problems through direct practicum. The data on thinking styles and critical thinking skills that have been obtained will be analysed and the findings will be used as a reference in answering research questions.

Yanpiaw Creative-Critical Style Test (YCCST) is an instrument consisting of 34 questions and its feasibility and validity have been confirmed through the product moment test with the results of a score of 0.81 for critical thinking style and a score of 0.85 for creative thinking style with a total score of 0.90 (Piawa, 2010). Meanwhile, the critical thinking skills instrument has been confirmed as feasible with a validity value of 0.84 and a reliability value of 0.87. The critical thinking skills instrument includes five indicators, namely interpreting, analysing, applying, evaluating, and concluding.

The correlation test conducted aims to see the correlation between superior (strong) critical thinking styles that will have high critical thinking skills and vice versa. Data analysis begins with prerequisites that include normality tests and linearity tests which are then continued with hypothesis testing, namely bivariate correlation tests and simple regression by applying the SPSS Statistics 27. This analysis is carried out to see the degree of closeness of the link between predictor variables and predictors based on the correlation coefficient value (Cindiati et al., 2021). The relationship or correlation between variables can be interpreted by referring to Table 2. Statistical tests are determined based on the objectives to be achieved in answering the problem formulation. Two tests must be met first before conducting a hypothesis test, namely the normality test and the linearity test. The normality test is carried out to see whether or not the data is normally distributed, while the normality test is carried out to see whether or there is not a linear link between the predictor and predictor variables. After these two tests are met, the bivariate correlation test and regression test statistics are applied. The application of a bivariate correlation test aims to confirm the correlation of thinking style with critical thinking skills. If the variables studied are stated to have a positive correlation, then a regression test is continued, which aims to confirm the strength of the correlation indicated by the findings of the correlation coefficient test.

Table 1. Interpretation of Correlation Coefficients between Variables (Sugiyono, 2010)

Score Range	Interpretation
0 – 0.19	Very Low
0.2 – 0.39	Low
0.4 – 0.59	Middle
0.6 – 0.79	Strong
0.8 - 1	Very Strong

3. FINDINGS AND DISCUSSION

According to the findings of the One-Sample Kolmogorov-Smirnov test, it is known that the group data is normally distributed with a significance value of 0.05 > 0.200. Furthermore, after it was confirmed that the prerequisite test was met, the data was continued with a linearity test to see whether critical thinking style has a significant linear relationship to critical thinking ability.

Table 2. The Findings of the Linearity Test

			Sum of Square	df	Mean Square	F	Sig.
Critical Thinking Skills* Critical Thinking Styles	Between Groups	(Combined)	4319.491	65	66.454	3.113	
		Linearity	2703.651	1	2703.651	126.648	
		Deviation from linearity	1615.840	64	25.247	1.183	.277
	Within Groups		982.000	46	21.348		
	Total		5301.491	111			

The linearity test (Table 2) showed a non-significant deviation from linearity (p = 0.277), confirming that a linear link exists between critical thinking styles and critical thinking ability. Furthermore, to see the extent of the closeness of the link between the critical thinking style variable and critical thinking ability, a bivariate correlation test was applied.

Table 3. The Findings of the Bivariate Correlation Test

		The score of Critical Thinking Style	The score of Critical Thinking Style
A score of Critical Thinking Style	Pearson Correlation	1	.714**
	Sig. (2-tailed)		.000
	N	112	112
A score of Critical Thinking Style	Pearson Correlation	.714**	1
	Sig. (2-tailed)	.000	
	N	112	112

The bivariate correlation test found that the research variables have a correlation indicated by the Sig. (2-tailed) value of 0.000, which is smaller than 0.05. Furthermore, the findings of the correlation test results also show that there is a positive link between the variables of critical thinking style and critical thinking skills with an R-value (count) of 0.714 which is positive (Table 4). The correlation coefficient of 0.714 indicates a strong positive link between students' critical thinking styles and their critical thinking ability.

Table 4. The Results of the Regression Test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.714a	.510	.506	4.85970

Predictors: (Constant), Score of Critical Thinking Style
Dependent Variable: Score of Critical Thinking Ability

Furthermore, the level of strength of the link between the critical thinking style variable and critical thinking ability is interpreted by the correlation coefficient value shown in Table 5.

Table 5. Coefficient Correlation

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	43.951	3.226		13.624	.000
	Skor Critical Thinking Style	6.229	.582	.714	10.700	.000

Dependent Variable: Skor Critical Thinking Ability

Table 5 explains that if students' critical thinking style increases, then critical thinking skills can also be estimated to increase by 6.229.

The positive relationship between thinking style and critical thinking ability highlights that individuals who consistently engage their habitual thinking patterns can enhance their critical thinking skills. Students who regularly absorb and process information develop their capacity to analyze problems, interpret scenarios, and apply knowledge effectively to resolve challenges. This finding underscores the significant role of thinking style in shaping and expanding critical thinking ability.

Supporting evidence from studies by Abdi (2012), Mayla et al. (2024), and Putri et al. (2022) confirms a positive correlation between thinking style and critical thinking ability, suggesting that thinking style can serve as a predictor of an individual's future critical thinking capabilities. Furthermore, Agoestanto and Shufah (2023) emphasized that thinking style is a critical factor in the development of students' critical thinking skills. Fauzi et al. (2020) also noted that thinking style influences problem-solving approaches, characterizing it as the manner in which individuals absorb, process, and utilize information to effectively address challenges.

Keegan et al. (2015) reinforced that a person's inherent critical thinking style facilitates effective information delivery and problem resolution. Hall and Starzec (2024) elaborated that an active critical thinking style fosters deeper critical engagement, yielding positive outcomes. Similarly, Utami et al. (2021) highlighted that a balanced thinking style equips individuals with comprehensive critical thinking skills, enabling effective problem-solving through integrated brain functions. Klinger (2006) further established that critical thinking style serves as a predictor of advanced cognitive processes and academic success.

According to Watson-Glaser, there are 7 components of thinking style strength, namely: 1) truth-seeking which includes independence and asking questions, 2) analytical: organized, planned, and reasonable, 3) inquisitive: has curiosity and in-depth investigation, 4) insightful: consistent and thinks before thinking), 5) open-minded: respects and adaptable, 6) systematic: structured, able to connect ideas, 7) timely: initiator, multitasking (Davies & Stevens, 2019). Thinking style is not about a person's ability, but rather the person's willingness to use the thinking skills they have. Thinking style is a person's way of learning something that describes their consistency in using thinking skills. Thinking style includes 7 dimensions or levels, namely thinking style, lateral thinking, decision-making, problem-solving, logical thinking, creative thinking, and critical thinking (Alexander, 2017). A person with a critical thinking style will have the motivation to implement the ideas or knowledge they have. Thinking style will generally be actualized depending on how a person solves the problems they face. In other words, thinking styles do not develop purely but are influenced by the external environment (Belousova & Pishchik, 2015).

These findings highlight the need for educators to integrate activities that enhance students' awareness of their thinking styles into teaching strategies. By guiding students to recognize and strengthen their critical thinking styles, teachers can better support the development of critical thinking

abilities—skills essential for academic success and effective problem-solving. The implications of this study are significant for education, serving as a foundation for identifying factors that enhance students' critical thinking.

These insights align with the findings of Hamidah et al. (2024), Jayanti & Muntahanah (2024), and Lemuel (2024), who recommend that educators innovate across curricula, strategies, methods, and instructional media to foster critical thinking abilities. As Permana et al. (2019) noted, advancements in knowledge and technology demand that teachers design learning experiences that accommodate and nurture critical thinking development.

Emir (2013) emphasized that providing students with an effective learning environment where they can freely apply their critical thinking styles optimizes their development. Students who fully engage their thinking styles benefit from enhanced critical thinking skills. Similarly, Sankararaman (2014) described critical thinking style as a dynamic mental process that thrives in active and effective environments, encouraging progressive cognitive engagement. Thinking styles, according to Sankararaman, evolve based on two key factors: the degree of control students exercise over their thought processes and the level of experience they accumulate. Consequently, thinking styles grow as students engage in thoughtfully designed activities and acquire new knowledge, emphasizing the importance of intentional and adaptive educational practices.

According to Cindia et al. (Cindiati et al., 2021), critical thinking abilities are referred to as parameters that students must have to be able to use other high-level thinking abilities. This is strengthened by the findings of an investigation applied by Al-Ghadouni (Al-Ghadouni, 2021) that paying attention to student's critical thinking ability is very essential for the world of education as an effort to answer the challenges of the era of Society 5.0 and Industry 4.0. Students who can use their thinking ability well will have a good understanding of the knowledge they receive. In addition, students who have critical thinking ability will be accustomed to using their thinking ability to connect every problem they face with the knowledge they have.

4. CONCLUSION

The findings from this study reveal a strong positive correlation (r = 0.714) between students' critical thinking styles and their critical thinking ability in biology learning. This suggests that students with a well-developed critical thinking style are more likely to demonstrate higher levels of critical thinking ability. The findings of this investigation indicate a strong positive correlation (r = 0.714) between students' critical thinking styles and their critical thinking ability in biology learning. This suggests that students with well-developed critical thinking styles are more likely to demonstrate higher levels of critical thinking ability. In summary, students' critical thinking styles are positively linked with their critical thinking ability in biology learning. Students who have critical thinking ability will influence or determine the level of students' critical thinking ability. Therefore, a teacher needs to accommodate the use of students' critical thinking styles to further develop students' critical thinking abilities. Teachers can consider using learning media relevant to the characteristics of students' learning styles such as audio-visual teaching materials and smartphone-integrated teaching materials. In addition, teachers also need to pay attention to contextual and meaningful learning methods such as learning that uses case method learning to hone students' critical thinking ability.

This research has limitations, namely, the limited number of samples used and the fact that it still focuses on biology learning. Therefore, further research can consider using larger samples to obtain holistic results. In addition, future researchers can investigate the link between thinking styles and critical thinking ability by applying other types of teaching materials that are relevant to students' thinking styles. This study also confirms and supports the existing theory that thinking style and critical thinking ability are two components that form a single unit and influence each other. Students who are accustomed to applying critical thinking styles will influence the way students think, convey information, communicate, and discuss. On the other hand, students with developed critical thinking ability will be accustomed to use their thinking habits actively. Extending and improving critical

thinking styles and ability in education is an important effort that can be made to produce students who can analyze and make decisions in finding solutions to problems in the industrial era 4.0.

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