Analysis of the Relationship Between Learning Styles and the Level of Critical Thinking Skills of Learners on Global Warming Material in High School

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Abstract
This study aims to determine the relationship between learning styles and the level of thinking skills of students on global warming material in high school. The research method used in this research is descriptive qualitative, involving research subjects as many as 69 students of class X phase E independent curriculum who are available and willing to be studied. The data were analyzed using Cramer's correlation coefficient, PHI correlation coefficient, lambda correlation coefficient, and TAU-B and TAU-C correlation coefficients. The results of the analysis are the Chi-Square count of the Cramer correlation coefficient, which is (14.399) > Chi-Square table (5.591), the Chi-Square count of the PHI correlation coefficient is (6.534) > Chi-Square table (3.841), the Chi-Square result of the lambda correlation coefficient is (38.687) > Chi-Square table (9.448), and the Chi-Square result of the TAU-B and TAU-C correlation coefficient is (33.051) > Chi-Square table (9.448). This means there is a significant correlation between students' learning styles and critical thinking skills on global warming material in high school, and the correlation coefficient still shows a reasonably strong interpretation. Students who have auditory and visual learning styles tend to have a higher level of critical thinking skills than students who have kinesthetic learning styles. This shows that there is a reasonably strong relationship between learning styles and critical thinking skills of students on global warming material in high school.
Keywords: critical thinking skills; learning style; statistics

INTRODUCTION

Indonesia is a country that pays great attention to the implementation process in its education, in which parents, teachers, and principals have an essential role (Kurniawati, 2022; Ummah et al., 2022; Widodo, 2024). The implementation of education must follow the applicable curriculum. The curriculum is a set of learning plans,

classroom management, media use, and technology for achieving learning objectives (Irvan et al., 2023; Lestari et al., 2023). The newest curriculum in Indonesia is the Merdeka curriculum. A Merdeka curriculum gives students the freedom to explore their skills and interests, so teachers have more freedom to be as creative as possible in teaching and to learn more about students' interests, talents, needs, and skills (Betari, 2023; Budiman et al., 2022; Setyaningsih et al., 2024).

In the curriculum of the twenty-first century, critical thinking skills are crucial. Nonetheless, several research findings suggest that Indonesian students' critical thinking skills still require development. However, several study findings indicate that there is still room for improvement in Indonesian students' critical thinking skills (Heryani et al., 2023). Students' critical thinking skills still need improved study (Chairatunnisa et al., 2023). According to Ennis (1993), five categories comprise the signs of critical thinking: giving concise explanations, mastering fundamental skills, making inferences, giving additional explanations, and coming up with plans and techniques. Teachers who dominate the learning process (teacher centre) are to blame for students' inadequate critical thinking skills. This has prevented students from developing their critical thinking skills, as demonstrated by the learning outcomes reflected in the requirements to meet learning goals (Arif et al., 2019; Kristiyanto & Indriayu, 2020). Instructors are crucial in helping students develop their critical thinking skills (Fikriyatii et al., 2022).

There are several reasons why students struggle with critical thinking. The teachers' repetitive participation in the educational process is the first contributing component. Instructors are crucial in helping students cultivate their critical thinking skills (Fikriyatii et al.,

2022). The use of appropriate learning paradigms impacts students' cognitive capacities. Problem-based learning methods are an effective way to help students develop their critical thinking skills (Putri et al., 2023), the learning model of STEM-PjBL (Kurniahtunnisa et al., 2023), combining the problem-based learning (PBL) learning approach with video assistance (Astra et al., 2024).

The second factor is teaching materials; teaching materials that only utilize printed books makes students feel bored. To overcome these problems, teachers can utilize electronic teaching materials like digital handouts (Akhsan et al., 2021) and STEM-based digital handouts as teaching materials (Murniati et al., 2022). The use of Google site-based e-modules (Susanti et al., 2023), scientific Critical Thinking (SCT)-based e-modules (Mahdian et al., 2024), econophysics E-modules (Lestari & Apsari, 2022), and e-modules integrated with STEM (Adhelacahya et al., 2023) are effective as teaching materials that can improve students' skills.

The third factor is the test instrument. In evaluating learning carried out by teachers, the instruments used have been unable to measure students' skills and have yet to be by the indicators of making test instrument questions. Consequently, manual and computer-based equipment development is required (Murniati et al., 2023). Students can use the critical thinking disposition based on gender instruments to measure their critical thinking skills (Syahfitri & Firman, 2022). Ennis indicators are a valuable tool for assessing pupils' critical thinking abilities. According to Ennis (1993), critical thinking indicators are divided into five categories: providing clear explanations, developing basic skills, drawing conclusions, providing more explanations, and formulating strategies and tactics.

The fourth factor is technologists; teachers often need to utilize technology

in the learning process and still do conventional learning. Several technologies can be applied to enhance students' critical thinking skills, including augmented reality technology, which significantly benefits the area of instruction (López-Belmonte et al., 2023). Augmented reality technology adds computer-generated perceptual information to real-world objects, offering a participatory encounter with the natural world (Garzón, 2021). For those interested in raising the standard of education, the freshness of augmented reality technology has a unique appeal (Muslim et al., 2021). In addition, artificial intelligence is a critical educational technology and digital learning tool in the 21st century (Tasci & Durmuscelebi, 2020). Artificial intelligence technology is effective in education today and in the future (Tartuk, 2023). Artificial intelligence can be utilized in educational activities (Kaban, 2023). In another study on artificial intelligence visualizing image concepts, it was determined that there is a high potential for using artificial intelligence-generated visuals for instructional purposes (Aktay, 2022). Here, conceptual perception in the learning process will be meaningful (Aydin et al., 2022).

The pupils' learning style is the fifth component that influences critical thinking skills. The study's findings demonstrate that students' critical thinking skills vary depending on their preferred learning style. Students who learn best visually have flawless criteria for critical thinking, whereas students who learn best auditorially have passable criteria for critical thinking. On the other hand, students who learn best through movement possess critical thinking skills that meet the necessary standards (Setiana & Purwoko, 2020). One method or cognitive talent for setting objectives is critical thinking. Every pupil has a unique way of learning (Apiati &

Hermanto, 2020). In other research, pupils' critical thinking skills are determined by their preferred mode of instruction. The findings demonstrated that different learning styles have different critical thinking skills. Critical thinking skills are usually highly developed in students who learn best visually. Third, auditory learners typically lack critical thinking skills. Fourth, the critical thinking skills of kinesthetic students are average (Wilujeng & Sudihartinih, 2021). The critical thinking skills of students' vary depending on their preferred learning approach. Students with visual learning methods' critical thinking skills fall into the critical group; those with auditory learning styles fall into the critical group; people with kinesthetic learning styles belong to the less critical group. On the other hand, students who learn best visually-auditory have critical thinking skills that fall into the critical category. Out of the three learning modes, the visual learner had superior critical thinking skills than the auditory and kinesthetic learners (Wasqita et al., 2022). Research on critical thinking skills based on students' learning styles reveals that, when it comes to various materials, pupils with visual learning styles are more adept at critical thinking than those with auditory and kinesthetic learning styles. In order to determine if the findings of this research analysis will be the same or different, the researcher intends to examine critical thinking skills as they relate to students' learning styles when studying high school global warming curriculum.

Following that, information was gathered through an interview with a teacher instructing class X on global warming and the distribution to 69 students in class X at SMA Negeri 3 Sekayu, a needs analysis questionnaire. The results showed that: (a) 86.95% of students have not done a learning style diagnostic test, so students need to do a

diagnostic test to find out their learning style; (b) 79.71% have difficulty in analyzing, solving problems, and drawing conclusions on global warming material, and 81.15% stated that learning still uses makeshift teaching materials. The teacher stated that some learners still need help discussing and evaluating global warming material. The teacher is also still trying to understand students' learning styles so that they can choose the proper learning method and improve their critical thinking skills. Students still learn a lot by memorizing to solve problems (Islahiyah et al., 2021). Low critical thinking skills mean that students cannot identify the information provided in the problem; they cannot assess, analyze, or draw conclusions. This is consistent with research (Aji et al., 2024), which shows that class X students in South Sumatra still need to improve their critical thinking skills regarding global warming content.

Based on the literature study, needs analysis, and interviews above. It is known that students' critical thinking skills are still in the low category. The use of inappropriate learning designs causes a low level of critical thinking skills. In choosing the right learning design, the teacher must conduct an initial diagnosis of students' learning styles. Teachers are essential in conducting initial diagnostic tests of students' learning styles. It is intended for learners to maximize and improve their critical thinking skills. Therefore, it is necessary to "Analyze Critical Thinking Skills Based on the Learning Style of Learners of Global Warming Material in High School."

METHOD
This study employs a quantitative descriptive methodology (Fernandez-Batanero et al., 2020). The goal of the qualitative descriptive technique is to characterize the learning styles of students and ascertain how their learning styles and critical thinking skills relate to

the secondary school curriculum on global warming. Study volunteers are not given therapy during the study or data collection; they are merely given devices. This attempts to present an accurate first picture based on the actual scenario to provide a general overview of the high school kids' learning style and level of thinking about global warming information.

The research was carried out to obtain an initial overview of students' learning styles and determine the connection between critical thinking skills and students' learning styles. Instruments used included five essay questions representing five indicators of critical thinking skills (Ennis, 1993), thirty multiple-choice questions about students' learning styles confirmed by three knowledgeable instructors in their domains, and one high school teacher about global warming materials. Meanwhile, the research subjects are two classes of sixty-nine pupils each; these students have embraced a Merdeka curriculum and are willing and able to be examined.

The data were analyzed using IBM SPSS version 22 and five distinct correlation coefficient tests: the TAU-B, TAU-C, lambda, PHI, and Cramer correlation coefficients.

Hypotheses:

H_0: No relationship exists between students' critical thinking skills on global warming materials in secondary schools and their learning styles.

H_1: A correlation exists between students' critical thinking skills regarding global warming content in high school and their learning styles.

Lambda correlation, PHI correlation, Cramer correlation, TAU-B and TAU-C correlation coefficients:

➢ Based on the chi-square value, H0 is approved, and H1 is denied if the computed chi-square value is less than the chi-square table.

> H0 is rejected and H1 is approved if the computed chi-square value is greater than the chi-square table.

Comparing significance values

> If the value of Approx. Sig. is less than 0.05. There is a substantial link between students' critical thinking skills on high school global warming material and their learning styles.

> If the approximate significance value is more than 0.05, no discernible relationship exists between students' critical thinking skills in high school global warming coursework and their learning methods.

Table 1 The degree to which learning style and critical thinking skills correlated (Kamran et al., 2022)

Correlation Coefficient Value	Interpretation
0.00 - 0.25	Very Weak Correlation
0.26 - 0.50	Moderate Correlation
0.51 - 0.75	Strong Correlation
0.76 - 1.00	Very Strong Correlation

RESULTS AND DISCUSSION

The results of the student learning style and thinking skills instrument tests are shown in Table 2.

Table 2 Test Results of Learning Styles and Critical Thinking Skills

		Critical Thinking Skills Level			Total
		High	Medium	Low	
Learning Style	Visual	31	3	3	37
	Auditory	2	5	10	17
	Kinesthetic	1	4	10	15
Total		34	12	23	69

The learning style instrument test consisted of 30 multiple choice questions and the student thinking skills instrument test consisted of 5 questions given to 69 students. Table 2 displays the findings from the assessment of students' learning preferences and their degree of critical thinking skills in the content related to global warming. Instruments were given to 69 students to identify their learning styles. 37 of the 69 pupils learn best visually, 17 learn best auditorily, and 15 learn best kinesthetically. Discovery of each student's preferred learning style: 69 students were required to complete five essay questions and critical thinking skills about global warming. Students with visual learning styles provided the results. According to the information, 31 pupils possess excellent critical thinking skills, three have moderate critical thinking, and three have low critical thinking skills. Then, out of the 17 students with auditory learning styles, it is known that 2 have high critical thinking skills, 5 have moderate critical thinking skills, and 10 have low critical thinking skills. Out of the fifteen students that have kinesthetic learning styles, it is known that one student has a high level of critical thinking skills, four have a moderate level, and ten have a low level of critical thinking skills. This demonstrates that pupils with a kinesthetic learning style typically lack the critical thinking skills of those who learn best visually or audibly. Research demonstrates that visual critical thinking skills are more effective in learning styles than aural and kinesthetic ones (Wasqita et al., 2022).

The first data analysis used Cramer's correlation coefficient to determine the correlation between students' critical thinking skills and their preferred learning styles. The outcomes are displayed in Tables 3 and 4.

Table 3 Chi-Square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.399[a]	2	.001
Likelihood Ratio	16.463	2	.000
Linear-by-Linear Association	13.606	1	.000
N of Valid Cases	69		

Table 4 Symmetric measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.457	.001
	Cramer's V	.457	.001
N of Valid Cases		69	

According to Table 3's Chi-Square calculation, the result is (14.399), while the Chi-Square table's result is (5.591) to the analysis results using the Cramer correlation coefficient using IBM SPSS Version 22. There was a correlation between the degree of critical thinking skills and learning style in high school global warming material since the calculation's Chi-Square value (14,399) > the Chi-Square table (5,591). As a result, H0 was rejected, and H1 was allowed. When comparing individuals with kinesthetic learning styles to those with auditory and visual learning styles, Learners with kinesthetic and auditory learning styles have lower thinking skills than learners with visual learning styles on global warming material.

In addition, the value of Approx. Sig. for the Cramer correlation coefficient in Table 4 shows a value of 0.001 < 0.050. This means a strong correlation exists between students' critical thinking skills and their learning styles in global warming materials in high school. Table 4 displays the Cramer correlation coefficient to analyze the relationship between critical thinking skills and learning style. With an interpretation of a relatively strong correlation, the Cramer correlation coefficient is 0.457. This suggests a considerable correlation between students' critical thinking skills and their learning styles in global warming materials in high school. Nominal data from IBM SPSS version 22 was used. The outcomes are displayed in Tables 5 and 6.

Table 5 Chi-Square tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.534[a]	1	.011		
Continuity Correction	5.293	1	.021		
Likelihood Ratio	6.750	1	.009		
Fisher's Exact Test				.012	.010
Linear-by-Linear Association	6.439	1	.011		
N of Valid Cases	69				

Table 6 Symmetric measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.308	.011
	Cramer's V	.308	.011
N of Valid Cases		69	

The PHI correlation coefficient study conducted with IBM SPSS Version 22

yielded findings for the Chi-Square count (6.534) in Table 5 and a Chi-

Square table (3.841), respectively. The Chi-Square count (6.534) value is greater than the Chi-Square table (3.841), indicating that H0 is rejected and H1 is approved. This suggests a relationship between the critical thinking skills of high school pupils studying global warming.

In addition, the estimated significance value (A Sig.) for the PHI correlation coefficient in Table 6 shows a value of 0.011-0.050. This indicates that this style significantly correlates with high school students' critical thinking skills regarding global warming. The PHI correlation coefficient, which indicates how this

relationship should be interpreted, is shown in Table 6.6. The PHI correlation coefficient, which has a value of 0.308, shows the interpretation of a moderately strong correlation. This indicates that there may be a significant relationship between learning styles and critical thinking skills in high school materials related to global warming.

The final data analysis also examined the association between students' critical thinking proficiency and learning styles using the lambda correlation coefficient. Nominal data from IBM SPSS version 22 was used. The outcomes are displayed in Tables 7 and 8.

Table 7 Chi-Square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.687[a]	4	.000
Likelihood Ratio	44.016	4	.000
Linear-by-Linear Association	.018	1	.894
N of Valid Cases	69		

Table 8 Directional measures

			Value	Asymp. Std. Error	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Lambda	Symmetric	.388	.089	3.532	.000
		high, medium, low dependent	.486	.098	3.920	.000
		auditory, visual, kinesthetic dependent	.281	.121	2.021	.043
	Goodman and Kruskal tau	high, medium, low dependent	.361	.082		.000[c]
		auditory, visual, kinesthetic dependent	.345	.070		.000[c]

The findings of the Chi-Square calculation in Table 7 are (38.687), and the Chi-Square table is (9.448) based on the analysis results utilizing lambda correlation coefficients using IBM SPSS Version 22. H0 was rejected, and H1 was allowed because the Chi-Square score (38,687) was determined to be higher than the Chi-Square table (9,448). As a result, there was a correlation between students' critical thinking skills on global-warming-related high school content and their preferred learning style.

Compared to individuals with auditory and visual learning styles, students with kinesthetic learning types typically possess a higher degree of critical thinking skills.

Furthermore, the table. The lambda correlation coefficient's eighth approximate significance value (Approx. Sig.) is 0.000 < 0.050. This indicates that kids' critical thinking skills are strongly correlated with high school global warming materials and their preferred learning approaches. As for the level of

interpretation of the connection between essential skills of thinking and learning style, the lambda correlation coefficient is shown in Table 8. The lambda correlation coefficient value is 0.388 with a strong correlation interpretation, which shows a strong connection between students' critical thinking skills and their learning style in global warming materials in high school.

Additionally, the correlation coefficients of TAU-B and TAU-C were utilized in the fourth data analysis to examine the association between students' critical thinking proficiency and learning style. Ordinal data was employed, and IBM SPSS Version 22 was used to analyze it. Tables 9 and 10 display the outcomes.

Table 9 Chi-Square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	33.051[a]	4	.000
Likelihood Ratio	39.533	4	.000
Linear-by-Linear Association	16.474	1	.000
N of Valid Cases	69		

Table 10 Symmetric measures

		Value	Asymp. Std. Error	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Kendall's tau-b	.477	.074	5.862	.000
	Kendall's tau-c	.425	.073	5.862	.000
	Spearman Correlation	.537	.079	5.217	.000[c]
Interval by Interval	Pearson's R	.492	.072	4.628	.000[c]
N of Valid Cases		69			

In light of the analysis's findings using the correlation coefficients of TAU-B and TAU-C using IBM SPSS Version 22, the Chi-Square computation in Table 9 yields the value (33,051), while the Chi-Square table is (9,448). Because the Chi-Square's value calculation (33.051) > the Chi-Square table (9.448), there was a correlation between learning style and students' critical thinking skills when it came to high school curriculum on global warming, as seen by the rejection of H0 and acceptance of H1. Comparatively speaking, students who learn best visually or audibly typically possess higher critical thinking skills than those with kinesthetic learning styles.

TAU-B and TAU-C in Table 10 show values of 0.000 <0.050. This means a significant correlation exists between students' critical thinking skills and

learning styles on global warming materials in high schools. As for the level of interpretation, table 10 displays the correlation coefficients of TAU-B and TAU-C, representing the relationship between learning styles and critical thinking skills. The correlation coefficient values for TAU-B and TAU-C were 0.477 and 0.425, respectively, with a reasonably strong correlation interpretation. This shows a relatively strong connection between students' critical thinking skills and learning styles about global warming materials in high school.

Research by Andari (Ismiati et al., 2021; Setiana & Purwoko, 2020) indicates that students with visual learning styles exhibit superior critical thinking skills compared to their auditory and kinesthetic counterparts. Visual learners' critical thinking skills

are notably elevated compared to those with auditory and kinesthetic learning styles (Wasqita et al., 2022). Students who exhibit visual learning styles often demonstrate higher critical thinking skills than kinesthetic and auditory learning styles (Wilujeng & Sudihartinih, 2021). The essential mathematical skills of students with visual learning styles are commendable, as they effectively meet vital indicators such as evaluation, analysis, interpretation, and inference (Safitri & Miatun, 2021). The correlation between students' critical thinking skills and visual, auditory, and kinesthetic learning styles is significant (Azizah et al., 2023). The findings of this study demonstrate a correlation between learning styles and critical thinking skills. Students who favour visual learning often succeed more than those who prefer auditory or kinesthetic learning styles.

CONCLUSION

In this study, the results obtained are the Chi-Square count of the Cramer correlation coefficient, which is (14.399) > Chi-Square table (5.591), and the Chi-Square count of the PHI correlation coefficient is (6.534) > Chi-Square table (3.841). The Chi-Square result of the lambda correlation coefficient is (38.687) > Chi-Square table (9.448), and the Chi-Square result of the TAU-B and TAU-C correlation coefficient is (33.051) > Chi-Square table (9.448). This means there is a strong link between students' critical thinking skills and their preferred methods of learning about global warming materials in high school, and the correlation coefficient still shows a reasonably strong interpretation. Pupils who learn best visually or audibly typically possess greater critical thinking skills compared to those with kinesthetic learning styles.

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