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The Relationship Between Understanding Science Concepts and Critical Thinking Skills of Elementary School Students

Tiara Anggun Az Zahra¹, Tiok Wijanarko^{*2}

Elementary School Teacher Education, Universitas Negeri Padang, Padang, 25131, Indonesia

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* Corresponding author:

E-mail: tiokwijanarko@fip.unp.ac.id

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ABSTRACT

Critical thinking skills are one of the four essential competencies required in the 21st century. One of the factors influencing critical thinking skills is the understanding of science concepts. This study aims to analyze the significant relationship between the understanding of science concepts and the critical thinking skills of elementary school students in Tujuh Koto Talago Village. A quantitative approach with a correlational research design was employed in this study. Research data were collected through written tests, consisting of multiple-choice questions to assess the understanding of science concepts and essay questions to evaluate critical thinking skills. Hypothesis testing was conducted using the Pearson Product Moment correlation method. The results indicate a correlation between the understanding of science concepts and students' critical thinking skills, as evidenced by a significance value of $0.001 < 0.05$. Thus, it can be concluded that there is a significant relationship between the understanding of science concepts and the critical thinking skills of elementary school students in Tujuh Koto Talago Village.

1. Introduction

The increasingly complex era of globalization raises various global problems such as economic competition, the Industrial Revolution 4.0, and environmental challenges that demand individual skills to compete and contribute effectively (Wijanarko et al., 2024). In facing these challenges, there are four 21st-century life skills known as the 4Cs, one of which is the ability to think critically (Fitria, 2021). The Foundation for Young Australians, (2022) reported that future jobs present a 30% higher demand for critical thinking skills than traditional jobs, and professions that require high critical thinking skills significantly compensate for an average salary of 40% higher. Despite this, the level of critical thinking skills globally is still a cause for concern (Anisa et al., 2021). According to the 2022 PISA (Program for International Student Assessment) report, the critical thinking skills of students in Indonesia are still lower than the average achieved by OECD

member countries (OECD, 2023). Of the 81 participating countries, Indonesia ranked 72nd with a math score of 372, far below the average of 472 given by the OECD.

Based on preliminary studies that the author has conducted in five elementary schools in Tujuh Koto Talago Village, it was found that there were variations in students' critical thinking skills. The results of interviews with fifth-grade teachers showed that of the five schools, one school showed good critical thinking skills, two schools were in the medium category, and the other two schools were in the low category.

One of the factors that influence critical thinking skills is the understanding of science concepts (Nugraha et al., 2022; Permana et al., 2019; Trianggono, 2017). Students with a deeper understanding of concepts tend to have better critical thinking skills because there is a mutually reinforcing relationship between these two factors in the problem-solving process (Nugraha et al., 2022; Trianggono, 2017). Good concept understanding affects students' critical thinking skills because by understanding basic concepts, students can analyze contextual problems, reason logically, and make decisions in problem-solving (Fauziah & Fitria, 2022).

Based on preliminary studies with fifth-grade teachers in five elementary schools in Tujuh Koto Talago Village, variations in the level of understanding of science concepts in students were found. The survey results show that the level of understanding of students' science concepts can be categorized into three groups, namely the good, sufficient, and low categories.

Research related to similar variables is more dominant at the secondary and tertiary education levels, covering 70% of the total 30 articles found, while research in elementary schools only reaches 30%. Thus, departing from the background description, the author is interested in research to reveal the correlation between the level of understanding of science concepts and the critical thinking skills of students in elementary schools, so that it can provide new insights in the context of basic education.

2. Methodology

Research Design

This research is a quantitative study with a correlational design. The quantitative approach is a method based on the principles of positivism, which aims to analyze phenomena in certain groups or samples where previously formulated hypotheses are tested through data analysis using statistical techniques (Danuri & Maisaroh, 2019). Correlational research is a research approach that aims to explore and analyze the presence or absence of a relationship between several variables under study (Yeni et al., 2018). This study was conducted in 2025 at elementary schools in Tujuh Koto Talago Village, Guguk District, Lima Puluh Kota Regency. The

target population of this research comprised all fifth-grade elementary school students in Tujuh Koto Talago Village, with a total of 121 students.

Data Collection Technique

The data collection process was conducted through assessments that included both written multiple-choice questions (15 items) and essay questions (5 items). These instruments were designed to evaluate students' comprehension of scientific concepts and their critical thinking abilities.

Research Instruments

The instruments in this study were science concept understanding questions and critical thinking questions developed based on the following indicators.

Table 1. Research Instrument Grid

Variable	Indicator	Question Number	Total
Understanding Science Concepts (X)	Explain	1, 2, 3	3
	Compare	4, 5, 6	3
	Give an example	7, 8, 9	3
	Classify	10, 11, 12	3
	Interpret	13, 14, 15	3
	Analysis	16	1
Critical Thinking Skills (Y)	Advanced explanation	17	1
	Inference	18	1
	Evaluation	19	1
	Strategy and Tactics	20	1
Total			20 items

Instrument Validity

The validity assessment of the instrument is based on content validity. This process involves an expert review (expert judgment) to ensure the instrument accurately represents the intended content.

Data Analysis Techniques

The data analysis process employs a correlation test. Before conducting the correlation test, prerequisite tests including normality, homogeneity, and linearity tests are performed. The prerequisite tests and correlation analysis in this study were conducted using SPSS 29.

3. Result and Discussion

Data on the Results of Understanding Science Concepts

After the data was processed using SPSS 29, the minimum score of the science concept comprehension test was 20, meaning that the lowest score of students in the science concept comprehension test was 20 out of 100. The maximum score is 93 out of 100, meaning that the student with the highest score gets a score of 93. The average test for understanding science concepts only reached 54.79. The standard deviation is 18.907 and the variance is 357.470. From this data, the

variable frequency distribution of the understanding of science concepts can be classified in the following table 2.

Table 2. Classification Table of Understanding Science Concepts

Category	Interval	Frequency
Very Low	$X < 26$	4
Low	$26 < X \leq 45$	32
Medium	$45 < X \leq 64$	44
High	$64 < X \leq 83$	31
Very High	$X > 83$	10

Based on Table 2, it can be seen that the majority of the level of understanding of science concepts of grade V students of elementary school in Tujuh Koto Talago Village, Guguak District, Fifty Cities Regency is in the medium category with the number of respondents as many as 44. The low category with the number of respondents was 32, the high category was with the number of respondents as many as 31. The very low category was 4 respondents, while students with a very high understanding of concepts amounted to 10 respondents. This shows that the level of understanding of science concepts of grade V students of elementary school in Tujuh Koto Talago Village is included in the medium category because the table shows the largest number. From the data, the distribution of variable frequencies of critical thinking skills can be classified in the following table.

Critical Thinking Ability Results Data

After the data was processed using SPSS 29, the lowest score on the critical thinking ability test was 33, while the highest score was 100. The average critical thinking ability test showed several 71.27. The standard deviation of the critical thinking ability test was 19.061 and the variance was 363.350. From the data, the variable frequency distribution of critical thinking skills can be classified in Table 3.

Table 3. Critical Thinking Ability Classification Table

Category	Interval	Frequency
Very Low	$X < 43$	10
Low	$43 < X \leq 62$	32
Medium	$62 < X \leq 81$	37
High	$81 < X \leq 100$	32
Very High	$X > 100$	10

Referring to the histogram in Table 3, it is evident that most fifth-grade elementary school students in Tujuh Koto Talago Village possess critical thinking skills at a medium level, with a total of 37 respondents falling into this category. The low category with the number of respondents was 32, and the high category with the number of respondents was 32. The very low category was 10 respondents, while students with a very high understanding of concepts amounted to 10 respondents. This indicates that the critical thinking skills of fifth-grade elementary school students in Tujuh Koto Talago Village fall within the moderate category, as evidenced by the table displaying the highest frequency in this range.

Normality Test

The normality test in this research was conducted using the SPSS version 29 software, employing the Kolmogorov-Smirnov (KS) method with a significance threshold of 0.05 (5%). If the obtained significance value exceeds 0.05 (5%), it indicates that the sample originates from a normally distributed population. Conversely, if the significance value is below 0.05 (5%), it suggests that the sample is derived from a non-normally distributed population. The outcomes of the normality test are presented in Table 4 below.

Table 4. Results of the Test of Normality of Understanding Science Concepts with Critical Thinking Skills

Variable	N	Asymp. Sig. (2-tailed)	Criteria	Conclusion
Understanding Science Concepts Critical Thinking	121	0,157	> 0,05	Normal

Based on Table 4, the normality test results indicate a significance value of 0.157, which is > 0.05 . This suggests that the data distribution for both variables in this study follows a normal pattern.

Homogeneity Test

The homogeneity test was conducted by comparing the obtained significance value (Sig.) with the predetermined significance level (α). The outcomes of this test are presented in Table 5.

Table 5. Results of the Homogeneity Test of Understanding Science Concepts with Critical Thinking Skills

Variable	N	Sig.	Criteria	Conclusion
Understanding Science Concepts Critical Thinking	121	0,126	> 0,05	Homogeneous

Based on Table 5, the significance value shows a figure of $0.126 > 0.05$. This means that the X variable (understanding of science concepts) and the Y variable (critical thinking ability) in this study have a homogeneous distribution.

Linearity Test

The linearity test was conducted using the Test for Linearity feature in SPSS version 29. The outcomes of this test are presented in Table 6.

Table 6. Results of the Linearity Test of Understanding Science Concepts with Critical Thinking Skills

Variable	N	Sig.	Criteria	Conclusion
Understanding Science Concepts Critical Thinking	121	0,706	> 0,05	Linear

Based on Table 6 about the results of linearity calculation using SPSS v 29, Deviation from Linearity shows a figure of $0.706 > 0.05$. This means that the X

variable (understanding of science concepts) and the Y variable (critical thinking ability) in this study have a linear relationship.

Correlation Test

A correlation analysis was conducted to determine whether a significant relationship exists between students' comprehension of scientific concepts and their critical thinking abilities. The findings of this analysis are presented in Table 7.

Table 7. Results of the Correlation Test of Understanding Science Concepts with Critical Thinking Skills

Variable		Understanding Science Concepts	Critical Thinking
Understanding Science Concepts	Pearson Correlation	1	0,579
	Sig. (2-tailed)		0,001
Critical Thinking	Pearson Correlation	0,579	1
	Sig. (2-tailed)	0,001	

Based on the data presented in Table 7, the correlation test results obtained through the Pearson Product Moment method using SPSS indicate a Pearson correlation coefficient of 0.579 with a significance level of 0.001 ($p < 0.05$). These findings suggest a statistically significant relationship between students' understanding of science concepts and their critical thinking abilities. With a correlation coefficient of 0.579, the relationship between variable X (understanding of science concepts) and variable Y (critical thinking skills) can be categorized as medium strong, falling within the range of 0.4 to 0.599. Furthermore, since the Pearson correlation coefficient is positive, the relationship between these two variables follows a positive direction. This implies that the higher a student's understanding of science concepts, the greater their critical thinking skills. Conversely, a lower level of conceptual understanding corresponds to lower critical thinking abilities.

Discussion

The findings of this study indicate a correlation between students' understanding of science concepts and their critical thinking skills. Consequently, students with a strong conceptual understanding tend to exhibit higher critical thinking skills, whereas those with weaker conceptual comprehension demonstrate lower critical thinking abilities. This is based on the research findings of Rachmadiansyah (2022) Showing that there is a close relationship between critical thinking skills and concept understanding. This conclusion is supported by a correlation coefficient of $0.73 > 0.381$, signifying a strong relationship between the two variables.

Based on this opinion, the ability to understand science concepts is important to improve so that students can think critically and logically. The findings indicated a significant positive relationship between students' comprehension of scientific concepts and their critical thinking abilities. In other words, students with a

stronger grasp of scientific concepts tend to exhibit higher levels of critical thinking. Conversely, those with a weaker understanding of science concepts demonstrate lower critical thinking skills. This is the opinion of Sari et al. (2016) that understanding of science concepts and critical thinking skills have a significant positive relationship with a correlation coefficient of 0.845.

Students with good concept understanding have a more structured mindset and capture logical information more quickly. Mastery of basic concepts allows students to analyze problems in a particular context, think systematically, and make rational decisions in the problem-solving process (Fauziah & Fitria, 2022). Students who excel in providing simple explanations and remembering concepts show that strong basic knowledge can improve critical thinking skills (Barasa, 2022).

In this study, it was found that the highest indicator of concept understanding obtained by students was the ability to explain. The highest indicator of critical thinking ability is the ability of strategy & tactics. The results of the analysis are by the theory of Explanatory Reasoning, which is often associated with the ability to develop effective problem-solving strategies. Individuals who can explain their thinking tend to have a deeper understanding of the problem, which allows them to develop better strategies (Lombrozo, 2016).

Fahreza et al. (2018) revealed that individuals who are able to express their thoughts clearly tend to have a deeper understanding of a problem, so they can design more effective strategies. Students with a high level of metacognition have the ability to identify and explain the core of the problem and its context better. In contrast, students with low levels of metacognition tend to have difficulty in recognizing and describing the core of the problem and its context clearly, designing and monitoring the strategies used, implementing strategies optimally, and evaluating the results of implementing strategies comprehensively.

Furthermore, the lowest ability to understand science concepts is giving examples. In critical thinking indicators, the lowest ability is the ability to analyze. The results of the analysis are in accordance with the findings of the research Trianggono (2017) that the relationship between the ability to provide examples and analysis is an important foundation in the development of conceptual understanding and creative thinking skills. The level of closeness of the relationship between the indicators of creative thinking ability and the ability to give examples is 0.7728. This means that the relationship between creative thinking ability indicators to the ability to give examples is 77.28%. The greater the value of the level of relationship indicates the stronger the relationship between the variables tested. The ability to provide relevant examples is an indicator of the success of the critical analysis process in problem-based learning (Daniswara, 2023).

In response to this, the role of teachers in developing students' critical thinking skills is needed, which can be started by improving students' understanding of science concepts, especially on indicators of giving examples and analysis. If

students' understanding of science concepts is good, their critical thinking skills are also good, but if students' understanding of science concepts is low, then so will their critical thinking skills.

4. Conclusion

Based on the findings and discussion, it can be concluded that there is a significant positive correlation between elementary school students' understanding of science concepts and their critical thinking skills in Tujuh Koto Talago Village. The study reveals that the most prominent indicator of conceptual understanding among students is their ability to explain. Meanwhile, the highest indicator of critical thinking skills is their proficiency in strategy and tactics. These analytical results align with the Explanatory Reasoning Theory, which is closely linked to the capacity for developing effective problem-solving strategies. Individuals who can articulate their thought processes tend to possess a deeper comprehension of problems, enabling them to formulate more effective strategies.

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