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The Relationship Between Students' Critical Thinking Skills in Mathematics Learning Reviewed from Reflective and Impulsive Cognitive Styles

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ABSTRACT
This study aims to determine the relationship and differences in critical thinking skills between students with reflective and impulsive cognitive styles in learning mathematics in college. Critical thinking skills are important to understand and solve complex mathematical problems. Cognitive style, which reflects an individual's preferences in processing information, can affect how students learn and think critically. The population of this study was 147 students, consisting of all students of the 2023 intake who took Mathematics courses, but the sample taken was 64 students. The research instrument used critical thinking skills and cognitive style tests. The critical thinking skills test is in the form of mathematical questions that require in-depth analysis and evaluation. In contrast, the cognitive style test can use instruments such as the Matching Familiar Figures Test (MFFT) to group students into reflective and impulsive cognitive styles. The quantitative data obtained will be analyzed using descriptive and inferential statistics. Statistical analysis can include correlation tests to see the relationship between cognitive style and critical thinking skills and difference tests to compare critical thinking skills between groups of students with impulsive and reflective cognitive styles. The study's results showed a significant relationship (<0.05) between critical thinking skills and students' cognitive styles in mathematics. There was a significant difference in critical thinking skills between students with impulsive and reflective cognitive styles. The differences were in the speed and accuracy of problem-solving, evaluation and decision-making skills, and understanding of mathematical concepts.

Keywords: Critical Thinking, Reflective, Impulsive

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INTRODUCTION

Critical thinking skills are essential competencies that students must have in the era of globalization and the rapid development of information technology. In reality, students' critical thinking skills are still low. This can be seen when students' learning is less confident and afraid to express opinions or ask things that they do not understand (Khasanah & Octavianti, 2017). In this case, efforts to improve learning in higher education must be able to optimize students' critical thinking skills.

Efforts to improve learning in higher education are the impact of the pandemic period when learning was carried out online. The result of online learning carried out around 2020-2022 was the difference in students' critical thinking skills in online and offline learning (Kertiyani & Sarjana, 2023). Meanwhile, students' critical thinking skills must always be honed and trained so that they can support problem-solving skills in learning in higher education.

Critical thinking involves analyzing, evaluating, and interpreting information logically and objectively, which is very important in learning mathematics. Critical thinking skills are one of the most crucial competencies for students, especially in mathematics learning (Astuti, 2024). Critical thinking includes analyzing problems in depth, evaluating arguments logically, and making decisions based on valid evidence (Susilowati & Sumaji, 2021). Critical thinking skills enable students to understand complex concepts, apply mathematical theories in various situations, and solve problems efficiently in mathematics learning.

In mathematics learning in college, critical thinking skills are crucial for understanding abstract concepts, solving problems, and developing a deep understanding of the material. Students with an impulsive cognitive style may have difficulty in this process because they tend to rush and lack in-depth analysis. Conversely, students with a reflective cognitive style tend to be better able to solve mathematical problems because

students are more careful and thorough in analyzing problems (Ni'mah, 2018). On the other hand, cognitive style, which refers to how individuals process information and solve problems, also plays a significant role in learning.

Cognitive style is how individuals process information and solve problems, affecting learning effectiveness (Appulembang, 2015). One of the relevant dimensions of cognitive style is impulsive and reflective cognitive style. Impulsive cognitive style is characterized by a tendency to make decisions or answers quickly without much consideration, often ignoring in-depth analysis and critical evaluation. In contrast, the reflective cognitive style is characterized by a tendency to think more deeply before making decisions, conduct careful study, and consider various alternative solutions. In solving mathematical problems, individuals with an impulsive cognitive style tend to be faster in answering questions but are less thorough or less careful in solving problems. This can be seen from the FRISCO critical thinking indicators (Focus, Reason, Inference, Situation, Clarity, Overview), which are only fulfilled by individuals with an impulsive cognitive style, namely Focus and Reason (Aini & Rosyid, 2022). Other research findings also explain the critical thinking process in solving mathematical problems by individuals with an impulsive cognitive style tend to be faster in solving problems and less careful in checking answers (Awaliya & Masriyah, 2022). From these studies, it can be concluded that impulsive cognitive style affects students' critical thinking skills in mathematics learning by making students faster in solving problems but less thorough and less careful in checking answers and less able to meet more complex critical thinking indicators.

This is in contrast to individuals with a reflective cognitive style who can better apply appropriate procedures correctly and have no difficulty understanding problems, interpreting problems, and determining strategies to answer a problem (Kusumawati et al., 2024). In mathematical communication skills, individuals with a reflective cognitive style tend to maximize their time in solving problems by rechecking their answers to correct and meet all indicators of mathematical communication skills (Nuyana et al., 2022). Individuals with a reflective cognitive style have a faster time in solving math problems, with an average time faster than students with an impulsive cognitive style. However, students with a reflective cognitive style also have a lower frequency of errors than students with an impulsive cognitive style (Rewi Konitah, 2022). Research has found that individuals with a reflective cognitive style can meet all FRISCO critical thinking indicators (Focus, Reason, Inference, Situation, Clarity, Overview). This can be seen from understanding concepts, analyzing information, and interpreting problems to evaluate the solutions' results (Oktaviani et al., 2020). Based on these studies, it can be concluded that individuals with a reflective cognitive style are more capable of solving mathematical problems correctly and carefully. In contrast, students with an impulsive cognitive style tend to be faster in solving problems but less thorough and less careful in checking answers. From the many studies, further research is needed to determine the relationship between critical thinking skills and students with reflective and impulsive cognitive styles in learning mathematics.

This study explores the potential for students' critical thinking skills in mathematics learning by considering the influence of reflective and impulsive cognitive styles. The questions to be answered through this study include: How is the relationship between reflective and impulsive cognitive styles and students' critical thinking skills in solving mathematical problems? Is there a significant difference in critical thinking skills between students with an impulsive cognitive style and students with a reflective cognitive style?

METHOD

This study uses quantitative descriptive research to determine and describe the relationship and differences in students' critical thinking skills in mathematics learning based on impulsive and reflective cognitive styles. The population and sample in this study involved students from the PGSD study program as the population, and the sample was taken randomly or purposively to obtain a good representation of the population. The population of this study was 147 students, consisting of all students of the 2023 intake who took Mathematics courses, but the sample taken was 64 students. The research instrument used critical thinking ability and cognitive style tests. The critical thinking ability test is in the form of mathematical questions that require in-depth analysis and evaluation.

In contrast, the cognitive style test can use instruments such as the Matching Familiar Figures Test (MFFT) to group students into reflective and impulsive cognitive styles. The quantitative data obtained will be analyzed using descriptive and inferential statistics. Statistical analysis can include correlation tests to see the relationship between cognitive style and critical thinking skills and difference tests to compare critical thinking skills between groups of students with impulsive and reflective cognitive styles.

RESULTS AND DISCUSSION

This study was conducted to determine the relationship between critical thinking skills and cognitive styles. The sample used was 64 students at PGSD Muhammadiyah University of Palangkaraya. The results of the normality and homogeneity tests using the SPSS application can be seen from:

Table 1. *Results of Normality and Homogeneity Tests*

	Sig. Minimum	Sig. Critical Thinking Skills	Sig. Cognitive Style
Normality	0,005	0,051	0,058
Homogeneity	0,005	0,808	

Source: Researcher (2024)

Decision-making in the normality and homogeneity test is if the significance value obtained is greater than 0.05, then the data is declared normal or homogeneous. Based on Table 1.1, it was found that the results of the normality test showed a significance value on critical thinking skills of 0.051> 0.05. While the significance value of cognitive style 058> 0.05. The significance of both variables is greater than 0.05, and it is concluded that the results of this research data are normally distributed. Meanwhile, the homogeneity test results obtained a significance value of 0.808> 0.05, so the research data was declared homogeneous. After conducting the normality and homogeneity tests, this study's data test was a hypothesis test using correlation and regression tests using SPSS.

In this case, to answer the research question, a correlation test was carried out to determine the relationship between critical thinking skills and students' cognitive styles in learning mathematics. Table 2 shows the results of the correlation test in this study.

Table 2. *Correlation Test Results*

		Kemampuan Berpikir Kritis	Gaya Kognitif
Kemampuan Berpikir Kritis	Pearson Correlation	1	.577**
	Sig. (2-tailed)		0,000
	N	64	64
Gaya Kognitif	Pearson Correlation	.577**	1
	Sig. (2-tailed)	0,000	
	N	64	64

**. Correlation is significant at the 0.01 level (2.tailed).

Source: Researcher (2024)

Based on Table 2, it was found that the correlation test using Pearson Correlation had a significance value of less than 0.05, so the data was declared correlated. Still, if it was more than 0.05, the data was said to be uncorrelated. Based on the research results, the significance value of critical thinking skills and cognitive styles was 0.000. In contrast, this value was less than 0.05, so it can be stated that critical thinking skills and cognitive styles are correlated. The results of the Pearson Correlation test in Table 2 are at 0.577, which, based on the correlation coefficient table, shows that the value is at a moderate correlation level. Furthermore, to find out how significant the difference is in critical thinking skills between students with impulsive cognitive styles and students with reflective cognitive styles, a different test was carried out with the Independent Samples Test, which can be seen in Table 3.

Table 3. *Independent Samples Test Results*

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil Tes Gaya Kognitif	Equal variances assumed	0,002	0,964	-5,687	62	0,000	-19,219	3,380	-25,975	-12,463
	Equal variances not assumed			-5,687	61,986	0,000	-19,219	3,380	-25,975	-12,463

Source: Researcher (2024)

Based on Table 1.3, it was found that the difference test using the Independent Samples Test had a significance value of less than 0.05, so the data is stated to have a difference, but if it is more than 0.05, then the data is said to have no difference. Based on the research results, the significance value of the reflective and impulsive cognitive styles shows a value of 0.000, where this value is less than 0.05, so it can be stated that there is a significant difference between individuals with reflective and impulsive cognitive styles.

Based on the description of the research results above, there is a significant relationship between critical thinking skills and students' cognitive styles in learning mathematics. Critical thinking skills and cognitive styles are interrelated aspects and greatly affect the process and results of learning mathematics in higher education. The following is a description of the significant relationship between critical thinking skills and students' cognitive styles in learning mathematics:

1) Reflective Cognitive Style and Critical Thinking Skills

Students with a reflective cognitive style tend to think deeply before making decisions. Students are more careful, consider various alternative solutions, and conduct a more in-depth analysis of the information obtained. The relationship with critical thinking skills of students with a reflective style tends to analyze problems more deeply. Students often show higher critical thinking skills. Students can evaluate arguments, find errors in thinking, and make more appropriate decisions. Reflective cognitive style helps students identify various possible solutions and consider the implications of each choice. This supports students' ability to solve complex mathematical problems (Puriani & Dewi, 2021). Reflective students are more open to feedback and tend to use constructive criticism to improve students' understanding and skills, improving critical thinking skills.

1) Impulsive Cognitive Style and Critical Thinking Skills

Students with impulsive cognitive styles tend to make decisions or answers quickly without much consideration and in-depth analysis. Students are more hasty in completing assignments and less likely to recheck their answers. Students with impulsive styles are often faster in providing answers, but this speed usually sacrifices accuracy and depth of analysis. As a result, students may be less able to critically evaluate arguments and tend to make mistakes when solving

mathematical problems. The lack of in-depth reflection and critical analysis in impulsive students reduces students' ability to see multiple perspectives and evaluate alternative solutions. Impulsive students are less open to feedback, tend to maintain students fast approaches, and do not utilize constructive criticism optimally to improve their critical thinking skills (Sangila & Safaria, 2017).

The difference in critical thinking skills between students with impulsive and reflective cognitive styles in mathematics learning can be seen from the following aspects:

1) Speed and Accuracy in Problem Solving

a. Impulsive Cognitive Style:

Students with impulsive cognitive styles tend to make decisions, provide answers quickly, and often rush to complete assignments without much consideration. The accuracy of students tends to act quickly. Impulsive students are less careful and often ignore important details in mathematics problems. Students also tend not to recheck answers, which can lead to errors (Elsa Elviani, 2022).

b. Reflective Cognitive Style:

Reflective students are slower in making decisions because students tend to analyze problems more deeply before providing answers. Students are more careful and precise in considering all aspects of the problem. Reflective students tend to recheck their answers to ensure their correctness. The analysis carried out by students with a reflective cognitive style is more in-depth and comprehensive, considering various possibilities and alternative solutions (Bakar et al., 2019).

2) Evaluation and Decision-Making Ability

a. Impulsive Cognitive Style:

Impulsive students often lack critical evaluation skills because they tend to accept information at face value without much consideration. Impulsive students also make decisions quickly, often ignoring the long-term implications or consequences of those actions (Rewi Konitah, 2022).

b. Reflective Cognitive Style:

Reflective students have better evaluation skills. Students tend to consider evidence, examine arguments, and assess the validity of information before making a decision. Reflective students also make decisions with careful consideration after going through a process of in-depth analysis and evaluation. This allows students to make more informed and effective decisions (Rewi Konitah, 2022).

1) Understanding Mathematical Concepts

a. Impulsive Cognitive Style:

Impulsive students also tend to complete assignments quickly. Impulsive students may have a shallow understanding of mathematical concepts. Impulsive students also tend to memorize procedures without really understanding the reasons behind them. It is more prone to conceptual errors because it does not consider in depth the relationship between the concepts being studied (Wulandari et al., 2024).

b. Reflective Cognitive Style:

Reflective students understand mathematical concepts more deeply. These students tend to study the relationships between various concepts and how these concepts are applied in various situations. These students are also more likely to use mathematical concepts appropriately in various contexts because of their deeper understanding (Wulandari et al., 2024).

CONCLUSION

The study's results showed a significant relationship (<0.05) between critical thinking skills and students' cognitive styles in mathematics.

The relationship between students' critical thinking skills and reflective styles is that students with reflective cognitive styles tend to analyze problems more deeply and often show higher critical thinking skills. The relationship between critical thinking skills and impulsive cognitive styles is that students with impulsive cognitive styles are often faster in providing answers, but this speed usually sacrifices accuracy and depth of analysis so that they are less able to evaluate arguments critically and tend to make mistakes.

Significant differences in critical thinking skills between students with impulsive and reflective cognitive styles are in the speed and accuracy of problem-solving, evaluation and decision-making skills, and understanding of mathematical concepts.

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