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Research Article

COGNITIVE PSYCHOLOGY STUDY AND MATHEMATICAL PROCESS SKILLS ON STUDENTS' ANSWERS IN MATHEMATICS LEARNING IN COMPARATIVE MATERIAL

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Abstract

This research explores the differences between the two schools regarding three key variables: students' cognitive psychology, mathematical processing skills, and responses to mathematics learning, specifically within the context of comparative material in Grade VII. Additionally, it seeks to compare these three variables to understand how they vary across the two institutions. The study adopts a quantitative approach, with purposive sampling used to select a sample of 120 Grade VII students from two junior high schools. Data were gathered using a questionnaire based on a Likert scale, and analysis was conducted using comparison tests through specialized data processing software. The results revealed significant differences in students' cognitive psychology, mathematical processing skills, and responses to mathematics learning between the two schools. These variations suggest underlying factors related to the learning environment, teaching strategies, or institutional differences that influence student performance and engagement in mathematics. What sets this study apart is its comprehensive comparison of cognitive and skill-based factors in mathematics learning across different school settings. Unlike previous research that examines these variables in isolation, this study integrates cognitive psychology and mathematical processing skills with student feedback, providing a holistic view of the learning experience. Doing so offers more profound insights into how school-specific conditions can shape students' cognitive and mathematical abilities, thereby informing more tailored educational strategies to improve mathematics learning outcomes across diverse educational contexts.

Keywords: Cognitive Psychology, Comperative Material, Mathematical Process Skills, Student Responses

INTRODUCTION

Learning is a complex and dynamic process that implies the acquisition of knowledge, skills, attitudes and values through diverse experiences (Dierks et al., 2016; Warfa et al., 2018; Dessi & Shah, 2023; Azis & Clefoto, 2024; Nuraeni & Inthaud, 2024). This process is not limited to formal classes, but also occurs through social interactions, observations and personal experiences. Learning is an essential basis for individual development and social progress (Everingham et al., 2017; Gersch, 2018; Lavega et al., 2018; Yohanie et al., 2023; Badiah, Saefullah, & Antarnusa, 2024; Fitriana & Waswa, 2024; Mardiati, Alorgbey, & Zarogi, 2024). Through learning, people can develop the ability to think critically, solve problems and make informed decisions. In the current digital era, technology has become an important component in the learning process, providing a wide access to information and educational resources that enrich the learning experience (Piercey & Militzer, 2017; Craig et al., 2021; Gürsoy, 2021; Asamoah et al., 2024). Therefore, understanding various aspects of learning is the key to designing educational strategies that are effective and relevant to the needs of the times.

The learning of mathematics plays a crucial role in the educational system because mathematics is a universal language used to understand and interpret the world around us (Della Purba & Kohlhoff, 2022; Theis & Rohana, 2022; Rosa et al., 2023). The process of learning mathematics involves developing analytical and logical skills through numerical, geometric and algebraic concepts. It is not only about memorizing formulas and procedures, but also about understanding the basic principles that support these concepts and how to apply them in various situations (Renties et al., 2018; Kjeldsen, 2019; Sukamdi, S., Lepik & Denkovski, 2023). The main challenge in mathematics learning is that abstract concepts are relevant and interesting for students (Zappone et al., 2019; Christidamayani & Kristanto, 2020; Nuryadi et al., 2020; Suwarni, 2021; Fernande, Sridharan, & Kuandee, 2024; Leekhot, Payougkiattikun, & Thongsuk, 2024). The use of visual aids, educational technology and contextual approaches can help students to see the importance of mathematics in everyday life and in their future careers.

A cognitive psychology is a branch of psychology that studies internal mental processes that include perception, memory, thinking, and problem-solving (Mahanani, 2017; Zysberg & Schwabsky, 2021; Agbi & Yuangsoi, 2022; Sari, Omeiza, & Mwakifuna, 2023). In an educational context, understanding how the brain processes information is fundamental to design effective teaching strategies (Loudon, 2019; Dias et al., 2021; Azizah et al., 2023; Helida, Ching, & Oyewo, 2023; Setiyani, Baharin, & Jesse, 2023; Habibi, Jiyane, & Ozsen, 2024). Cognitive psychology helps teachers understand how they learn, how to retrieve information and how to solve problems. It also includes research on cognitive load, which refers to the mental effort required to process information at the same time (Ahn & Kwon, 2020; Verschaffel, 2020; Triyasmina et al., 2022; Mizian, 2023). By understanding these principles, teachers can design learning materials that optimize students' cognitive ability, reduce confusion, and increase information retention. For example, breaking down complex information into smaller pieces and providing Concrete examples can help students process and understand difficult concepts.

The skills of mathematical processes are essential skills that include analysis, reasoning and problem solving in a mathematical context. This capability implies a series of systematic steps that are used to understand and solve mathematical problems (Banks et al., 2018; Suryawati & Osman, 2018; Li & Dong, 2019; Binti M & Adeshina, 2024). Students who master this ability to identify problems, choose appropriate methods to solve them and evaluate their results (Kusuma, 2020; Vartiainen & Kumpulainen, 2020; Papyrina et al., 2021). Mathematical process skills in the soil are important for academic success in mathematical subjects, but also for the development of critical and logical thinking skills that can be applied in various situations of life (Sauvé et al., 2018; Kleij, 2019; Putri & Mufit, 2023; Darmatiara et al., 2024). The development of these skills can be strengthened through regular practice, real problem solving and the use of visual aids that help students visualize abstract concepts. Therefore, mathematical process skills play an important role in the formation of a critical and adaptive analytical mentality.

This study offers a new contribution in the context of the application of Technology-Based Mathematical Process Skills and Cognitive Psychology which has not been widely applied in the education system in Indonesia, especially at the junior high school level. Most previous major studies (e.g., Daniel, 2016; Souad & Korti, 2018) have shown that the application of cognitive psychology principles can improve the ability to retain and transfer knowledge across disciplines. However, this study focuses on the integration of local wisdom through the traditional game Hadang from Jambi province in technology-based learning, which has never been widely explored before. By combining technology and local elements, this study aims to not only improve mathematical process skills but also foster cultural awareness in students.

This study was conducted in Jambi province, Indonesia, involving junior high school students as the main subjects. The integration of traditional games in technology-based learning designs creates a locally relevant and unique approach, which has never been studied in depth in this area. This provides a rich new context and potential for educational innovation that focuses on developing students' mathematical process skills and cognitive psychology while taking into account local cultural backgrounds.

RESEARCH METHOD

This research applies quantitative methods with a comparative methodological approach. A comparative type of quantitative approach is used to compare the most variables or groups in research (Palermo et al., 2019; Şahintepe et al., 2020; Wahjusaputri & Bunyamin, 2022). In the context of this study, a comparative approach is used to investigate differences or correlations between certain variables. This method generally involves collecting numerical data and applying statistical analysis to test hypotheses or identify possible patterns in the data.

The population of this studio was 120 students from two schools, namely, junior high school 7 Muaro Jambi and junior high school Elhafidziyah. The sampling technique is random sampling. The sample for this research came from class VII, totaling 4 classes, with 30 students being the subjects studied. The reason to select research subjects of VII is because the school has carried out a lot of learning of mathematics so that the variables of cognitive psychology of students can identify themselves in the learning of mathematics.

The instruments of this study used cognitive psychology questionnaires for students and mathematics learning questionnaires. Hence, the table used consists of 36 items valid in this instrument using a Likert scale. The scale consists of 4 points with a value of very good being 4 , good being 3, not good being 2, very bad being 1. Each statement is representative of each indicator of independent character and understanding of concepts. The focus of this investigation is on 36 indicators.

Table 1. Grid of student cognitive psychology instruments

Variables	Indicators	Total Items
Cognitive Psychology	Attention	1,2,3 ,4,5
	Memory	6,7,8,9,10
	Problem Solving	11,12,13,14
	Critical Thinking	15,16,17,18,19
	Decision Making	20,21,22,23,24
	Information Processing	25,26,27,28,29
	Metacognition	30,31,32,33
	Creativity	34,35,36
	Total	36

This research uses a Likert scale consisting of 4 categories, so there are intervals in each category, and the intervals in each category can be seen in the following table. The categories of mathematical process skills for learning mathematics are shown in Table 2.

Table 2. Grid of instruments of students' mathematical processing skills for learning mathematics.

Variables	Indicators
Mathematical process skills	Observation capacity
	Calculation capacity
	Measurement capacity
	Capacity of classification
	Capacity to find relationships
	Capacity to make predictions
	Capacity to conduct research
	Capacity to collect and analyze data
	Capacity to interpret data
	Capacity to communicate results

After explaining the grid of instruments of indicators of cognitive psychology of students, measurements were carried out through descriptive statistical tests. Student cognitive psychology category. The categories of responses of students to learning mathematics are shown in Table 3.

Table 3. Grid of student response instruments for mathematics learning

Variables	Indicators	Total articles
Response to the student	Answer	1,2,3,4
	Relevance	5,6,7,8,9
	Attention	10,11,12,13
	Satisfaction	14,15,16,17
	Sure of itself	18,19,20,21
Total		21

After explaining the grid of instruments of indicators of cognitive psychology of students, measurements were carried out through descriptive statistical tests. Student cognitive psychology category.

Table 4. Categories of cognitive psychology of students

Category	Range of variables		
	Generic skills of the student	Mathematical process skills.	Students respon
Very not good	36.0 – 63.0	10.0-17.5	21.0-36.75
Not good	63.1 – 90.0	17.6-25.0	36.85-52.75
Good	90.1 – 117.0	25.1-32.5	52.85-68.25
Not good	117.1 – 144.0	32.6-40.0	68.35-84.0

This research began with the distribution of questionnaires, followed by the analysis of quantitative data and the identification of findings for future research. During the stage of data collection, 120 students were killed by two schools who completed a body. The collected data were then analyzed through a process of coding, selection of relevant data and analysis using SPSS software with descriptive and inferential statistical tests. Firstly, descriptive statistics are used to provide a general view of the cognitive psychology of students (Ghavifekr & Rosdy, 2015; Amrhein et al., 2019). Then, assumption tests are performed such as normality, homogeneity and linearity tests. The normality test evaluates whether the data follow a normal distribution, the homogeneity test examines the equality of variance between two different groups of data and the linearity test evaluates the linear relationship between two variables. The hypothesis test was then performed using the t test and the post hoc test. The t-test compares two groups of data, while the regression test evaluates the relationship between two variables. Data analysis using SPSS involves calculating frequencies, means and standard deviations. The data collection process was carried out by selecting the students as a second research category and delivering questionnaires on their cognitive psychology. Figure 1 shows the procedures for collecting data used in this study.

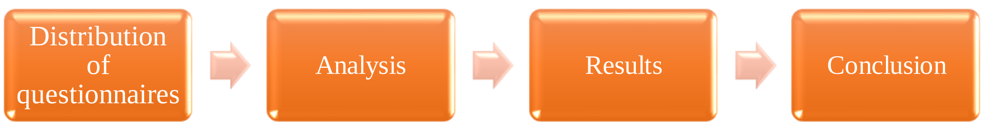

Figure 1. Research procedure

RESULTS AND DISCUSSION

The results of the descriptive cognitive psychology of students in mathematics learning are presented.

Table 5. Description of students' cognitive psychology tests

Response		Intervals	F	%	Category	Mean	Median	Min	Max
Junior 7 MJ	VIIA	36.0 – 63.1	0	0	Very not good	3.20	3.00	2.00	4.00
		63.1 – 90.0	2	10	Not good				
		90.1 – 117.0	11	55	Good				
		117.1 – 144.0	7	35	Very good				
	VIIB	36.0 – 63.1	0	0	Very not good	3.10	3.00	2.00	4.00
		63.1 – 90.0	4	20	Not good				
		90.1 – 117.0	9	45	Good				
		117.1 – 144.0	7	35	Very good				
E Middle School	VIIA	36.0 – 63.1	2	10	Very not good	2.85	3.00	1.00	4.00
		63.1 – 90.0	3	15	Not good				
		90.1 – 117.0	8	40	Good				
		117.1 – 144.0	7	35	Very good				
	VIIB	36.0 – 63.1	3	15	Very not good	2.75	3.00	1.00	4.00
		63.1 – 90.0	4	20	Not good				
		90.1 – 117.0	7	35	Good				
		117.1 – 144.0	6	30	Very good				

According to the results of the table 5, it can be said that junior high school 7 Muaro Jambi and junior high school Elhafidziyah classes VII A, VII B are superior in the good category. The following table presents a description of the descriptive statistical tests on the students' mathematical processing skills.

Table 6. Description of the test of students' mathematical processing skills

Response		Intervals	F	%	Category	Mean	Median	Min	Max
Junior 7 MJ	VIIA	10.0 – 17.5	0	0	Very not good	3.10	3.00	2.00	4.00
		17.6 – 25.0	4	20	Not good				
		25.1 – 32.5	9	45	Good				
		32.6 – 40.0	7	35	Very good				
	VIIB	10.0 – 17.5	2	10	Very not good	3.25	3.00	1.00	4.00
		17.6 – 25.0	3	15	Not good				
		25.1 – 32.5	9	45	Good				
		32.6 – 40.0	6	30	Very good				
E Middle School	VIIA	10.0 – 17.5	1	5	Very not good	3.15	3.00	1.00	4.00
		17.6 – 25.0	4	20	Not good				
		25.1 – 32.5	8	40	Good				
		32.6 – 40.0	7	35	Very good				
	VIIB	10.0 – 17.5	6	30	Very not good	2.85	3.00	1.00	4.00
		17.6 – 25.0	4	20	Not good				
		25.1 – 32.5	5	25	Good				
		32.6 – 40.0	5	25	Very good				

According to the results of the table 6, it can be said that junior high school 7 Muaro Jambi and junior high school Elhafidziyah classes VII A, VII B are superior in the good category. The following table 7 presents a description of the test of description of students' responses in learning mathematics.

Table 7. Description of the test of students' responses to mathematics learning

Response		Intervals	F	%	Category	Mean	Median	Min	Max
Junior 7 MJ	VIIA	21.0 – 36.75	0	0	Very not good	2.85	3.00	2.00	4.00
		36.85 – 52.75	3	15	Not good				
		52.85 – 68.25	10	50	Good				
		68.35 – 84.0	7	35	Very good				
	VIIB	21.0 - 36.75	2	0	Very not good	2.75	3.00	1.00	4.00
		36.85 – 52.75	3	15	Not good				
		52.85 – 68.25	8	40	Good				
		68.35 – 84.0	7	45	Very good				
E Middle School	VIIA	21.0 - 36.75	1	5	Very not good	3.15	3.00	1.00	4.00
		36.85 – 52.75	4	20	Not good				
		52.85 – 68.25	8	40	Good				
		68.35 – 84.0	7	35	Very good				
	VIIB	21.0 - 36.75	2	10	Very not good	3.25	3.00	1.00	4.00
		36.85 – 52.75	4	20	Not good				
		52.85 – 68.25	8	45	Good				
		68.35 – 84.0	6	30	Very good				

According to the results of the table 7, it can be said that junior high school 7 Muaro Jambi and junior high school Elhafidziyah classes VII A, VII B are superior in the good category.

Table 8. Study of Cognitive Psychology for Students, Mathematical Process Skills and Answers of Students to Mathematics Learning

Variable	School	Q	Df	Sig (2-tailed)	Mean Difference
Cognitive Psychology	Junior high school 7 MJ	17.234	60	.022	70.55364
	Junior high school Elhafidziyah MJ	18.236	60	.023	75.55634
Mathematical Process Skills	Junior high school 7 MJ	14.451	60	.021	75.55264
	Junior high school Elhafidziyah MJ	15,322	60	.020	70.51234
Students Response	Junior high school 7 MJ	15.454	60	.024	65.55254
	Junior high school Elhafidziyah MJ	16.321	60	.025	60.51224

Based on the previous table 8, it can be interpreted that there is a comparison between the cognitive psychology of students and the answers of students in both schools, as seen in the results sig. (of the colas) less than 0.05. The following table presents a post hoc study of the cognitive psychology of students, its mathematical processing skills and its answers to mathematical learning. The following table presents the interpretation of the cognitive psychology of the students, the skills of the mathematical processes and the answers of the students to the learning of mathematics in junior high school 7 Muaro Jambi and junior high school Elhafidziyah.

Table 9. Interpretation of students' cognitive psychology, mathematical process skills and students' responses to mathematics learning in junior high school 7 Muaro Jambi and junior high school Elhafidziyah

School	Value	F	Hypothesis df	Df error	Sig.
Junior high school 7 MJ	0.0223	352.811	3.000	17.000	0.000
Junior high school Elhafidziyah MJ	0.0223	352.811	3.000	17.000	0.000

The continuation is a post hoc study that uses Tukey to interpret cognitive psychology, mathematical process skills and the answers of students to learning mathematics in junior high school 7 Muaro Jambi and junior high school Elhafidziyah.

Table 10. Post hoc study that uses Tukey to interpret cognitive psychology, mathematical process skills and student responses to mathematical learning in junior high school 7 Muaro Jambi and junior high school Elhafidziyah

School	N	Tukey HSD[a,b]	Subset for alpha = 0.025
Junior high school 7 MJ	60	26.5365	28.0875
Junior high school Elhafidziyah MJ	60		27.0865
Sig.		10000	0.997

In the results of descriptive statistical research, the researchers probaron the learning model for students implemented in junior high school 7 Muaro Jambi and junior high school Elhafidziyah. There are 2 classes in each school, namely, VII A, VII B with 30 students for a total of 120 in each class. With studies that have been carried out on descriptive statistics, there are 36 indicators of cognitive psychology, 10 indicators of mathematical process skills, 21 indicators of answers from students to the learning of mathematics that needs attention. The results of descriptive statistical tests are used to measure the process skills of students in relation to problem-based learning and problem-solving as a learning paradigm (Fuad et al., 2017; Molefe & Aubin, 2021; Astalini et al., 2024). According to the previous indicators, junior high school 7 Muaro Jambi has a higher percentage of cognitive psychology, mathematical processing skills and responses from the students that junior high school Elhafidziyah, how it detaches from the results of the studies that have been carried out. This shows that cognitive psychology in junior high school 7 Muaro Jambi is superior to that applied in junior high school Elhafidziyah.

Based on the results of the normality study presented in Table 8, it can be concluded that the cognitive psychology data of the students, the mathematical process skills and the answers of the students to the learning of mathematics in the schools are distributed normally. This can be seen in the Kolmogorov-Smirnov significance value, which is greater than 0.05. La prueba de linealidad que se muestra en la Tabla 9 muestra que los datos de las dos escuelas tienen una relación lineal. The significance value of the linealidad sample is higher than 0.05, which indicates that there is a linear relationship between the variables that are measured (Kuhfeld & Soland, 2021). The results of the homogeneity study presented in Table 10 show that the analized data are homogeneous. This is evidenced by a significance value greater than 0.05 in the Kolmogorov-Smirnov practice, which means that the varianza entre grupos de datos es similar.

The results of the study have been shown in Table 11 that there are significant differences between the cognitive psychology of the students and the answers of the students to the learning of mathematics in the schools. El valor de significancia (de dos colas) es menor que 0.05, lo que indica que existe una diferencia significativa entre los grupos de datos comparados. In addition, post hoc studies were also carried out to evaluate the relationship between the cognitive psychology of students and their answers to mathematics learning (Piercey & Militzer, 2017; Warfa et al., 2018). These results show a significant difference, which indicates that the variables of cognitive psychology influence the responses of students in mathematics learning.

In general, the results of this investigation show that both junior high school 7 Muaro Jambi and junior high school Elhafidziyah have students with good categories of cognitive psychology and mathematical process skills. This is reflected in the results of descriptive tests, normality, lineality, homogeneity, practice and regression tests carried out. These results provide important information about the state of the cognitive psychology and mathematical skills of the students, which can be used to develop teaching strategies that are more effective and respond to the needs of the students.

This research is in line with research (Cantor et al., 2019) that considers aspects of cognitive psychology, but the difference is rooted in the focus that involves the schools, an aspect in the cubierto in previous investigations. Cognitive psychology provides a deep understanding of how humans process information, make decisions and solve problems in an efficient way. By using concepts of cognitive psychology, we can develop strategies and techniques to improve cognitive performance, overcome mental disorders and improve the quality of life in general.

The implications of this research indicate that a deep understanding of cognitive psychology and the mathematical process skills of students are very important to increase the effectiveness of mathematical learning. The results of the investigations that show a significant relationship between cognitive psychology and the responses of students in mathematics learning indicate that teachers should pay attention to the cognitive aspects of students when planning and implementing learning. By integrating teaching strategies that support cognitive development and mathematical thinking processes, such as deeper problem solving and project-based approaches, teachers can increase student participation and learning outcomes (Argaw et al., 2017; Gersch, 2018; Hidayati et al., 2020; Prambanan, Yathasya, & Anwar, 2023; Astalini et al., 2023). In addition, these hallazgos alienate the need for a teacher training that focuses on teaching techniques that support the skills of mathematical processing and cognitive development, which in turn can result in a higher academic performance and a better understanding of mathematical concepts among students.

One of the important contributions of this investigation is the enfasis in the mathematical process skills of students and cognitive psychology in the context of learning mathematics, which is a relatively new point of view in the educational literature. This research provides a deeper understanding of how aspects of the cognitive psychology of students can influence their answers in mathematics learning, as well as how the skills of mathematical processes can play a role in the understanding of mathematical concepts (Banks et al., 2018; Misastri, Wirayuda, & Syarbaini, 2023). Focusing on these aspects, this research provides a solid basis for the development of more holistic and effective teaching strategies, which can improve the quality of mathematics learning and enrich the general learning experience of students (Khotimah & Mahmudah, 2021; Sherif et al., 2021). By broadening the understanding of the importance of cognitive psychology and the skills of mathematical processes in the context of mathematical learning, this research provides significant new contributions to the development of teaching practices oriented to a better understanding and academic performance of students**.**

CONCLUSION

Based on the results of hypothesis studies, research studies and data analysis, the conclusion of this research is 120 samples of learning models based on problems of classes VII A, VII B. This research was carried out by junior high school 7 Muaro Jambi and junior high school Elhafidziyah. From the results of the study of description it can be concluded that junior high school 7 Muaro Jambi is more superior and superior in comparison with junior high school Elhafidziyah. Based on the results of the research and post hoc, it can be concluded that there are differences and comparisons in the three variables, namely, cognitive psychology, mathematical process skills and answers from students to learning mathematics in the schools. The researchers believe that they carry out more research to explore the effectiveness of various cognitive-based teaching methods, such as cooperative learning, problem-based learning or the use of educational technology to improve students' understanding of comparative material.

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