



## Logical Reasoning Ability and Memory Ability as Determinants of Senior Secondary School Students' Achievement in Mathematics in Ukanafun Education Zone, Akwa Ibom State

**Joseph, Victor Alphonsus & Ugwuanyi, C. C.**  
Department of Science Education, University of Nigeria, Nsukka  
**Corresponding author:** josephvictoralphonsus@gmail.com

### Abstract

This study examined logical reasoning ability and memory ability as determinants of senior secondary school students' achievement. To guide the research, two research questions and two null hypotheses were stated. With a population of 3802 SSII students from 21 public secondary schools in Akwa Ibom State, a correlational survey research design was used. A multiphase sampling process was used to choose a sample of 364 SSII students. The Mathematics Achievement Test (MAT), Memory Ability Test (MeAT), and Logical Reasoning Ability Test (LRAT) were used to gather data; the MAT underwent content validation. Based on the Kuder-Richardson 20 (K-R20) formula, the dependability coefficients for MAT, MeAT, and LRAT were 0.72, 0.87, and 0.98, in that order. Simple linear regression was used for data analysis, with Regression ANOVA being used to test the hypotheses and the coefficient of determination addressing the research issues. Testing of the hypotheses was done at the significance level of 0.05. The results showed that students' achievement in mathematics was highly influenced by their logical thinking and memory skills, suggesting that these skills positively predict mathematical performance. These findings led to the recommendation that the government and school administration hold regular conferences and seminars for mathematics teachers in order to create a dynamic and encouraging environment that improves students' ability to reason logically and retain information for better test scores.

**Keywords:** Achievement, Logical Reasoning Ability, Mathematics, Memory Ability, Students.

### Introduction

Mathematics is integral to all aspects of life, encompassing numbers, symbols, and shapes. As noted by Nwoye, Okoye, Ugwuanyi, Eze, and Odo (2019), it originates from studying figures and computing numbers. Mathematics is the backbone of numerous academic fields and is vital for scientific and technological knowledge, which is crucial for a nation's socioeconomic growth (Chand, Prasad, Chaudhary, & Chand, 2021). Ojimba (2012) asserts that science requires mathematics to function, and that without science, modern technology and society as a whole would not exist. As a result, advances in science and technology depend on mathematics.

Mathematics is essential for success in school since it is necessary for vocations in science, like engineering, medicine, and pharmacy. As of 2014, mathematics is required as a core subject in secondary school curricula by the Federal Republic of Nigeria (FRN). It is necessary to advance from Junior Secondary School to Senior Secondary School and to

be admitted into Nigeria's post-secondary educational institutions via the Joint Admission and Matriculation Board (JAMB). It is mandatory at both primary and secondary school levels.

Despite its importance, students' performance in mathematics has been poor over the years, as indicated by chief examiner reports (2016-2023). This decline is attributed to factors such as negative attitudes, lack of interest, poor perceptions of mathematics (Chand et al., 2021), ill-discipline, language barriers, and poor attitudes among learners (Mabena, Mokgosi & Ramapela, 2021). Other contributing factors include poor teaching environments (Isack, 2015) and the strictness of mathematics teachers (Jameel & Ali, 2016). However, there is limited focus on psychological aspects like logical reasoning ability and memory ability, which could significantly impact students' learning of mathematics.

Logical reasoning ability is the capacity to think broadly and solve problems logically and



consciously. It is essential for understanding and creating meaningful learning experiences in any subject (Hooda & Devi, 2018). Maiti (2017) emphasizes that mathematics heavily involves reasoning, making logical reasoning ability a potential influence on mathematical achievement. Frosch and Simms (2015) define logical ability as applying logical concepts in mathematics, such as understanding the inverse relationship between addition and subtraction. Agah and Lamido (2015) highlight that logical reasoning aids students in solving mathematical problems correctly. Despite its importance, the extent to which logical reasoning affects students' mathematics achievement has not been thoroughly investigated, prompting this study to explore its impact.

Memory ability, often referred to as working memory, is a student's capacity to retain and manipulate information for short periods. Gathercole and Alloway (2008) describe working memory as a mental workspace essential for daily activities. In mathematics, students need to remember and apply information provided by their teachers, especially during tests and exams. Since mathematics involves numerous formulas, axioms, laws, rules, and theorems, working memory is crucial for storing and recalling this information. Despite its importance, there is a lack of empirical research on how memory ability determines students' mathematics achievement, necessitating further investigation into its role. Therefore, "the researcher believed that making findings as to how much it contributes to students' academic achievement in mathematics may help in tackling students' poor academic achievement in mathematics to the barest minimum.

### Research Questions:

1. What is the amount of variation in students' achievement in mathematics that is accounted for by logical reasoning ability?
2. What is the amount of variation in students' achievement in mathematics that is accounted for by memory ability?

### Hypotheses:

1. The amount of variation in students' achievement in mathematics that is accounted for by logical reasoning ability is not significant.
2. The amount of variation in students' achievement in mathematics that is accounted for by memory ability is not significant."

### Methods

The research was conducted in the Ukanafun Education zone of Akwa Ibom State using a correlational survey research design. The target population was 3,802 SSII students from 21 public secondary schools in the state, and a sample of 364 SSII students was chosen through a multistage sampling method. Initially, proportionate random sampling selected 2 schools from Ukanafun L.G.A and 5 schools from OrukAnam L.G.A, making a total of 7 schools. Next, simple random sampling was used to choose two SSII classes from each selected school, resulting in 14 classes. The final sample included all students from these classes: 2 classes had 29 students each, 4 classes had 28 students each, 5 classes had 25 students each, and 3 classes had 23 students each, totaling 364 students.

Data collection instruments included the Logical Reasoning Ability Test (LRAT), Memory Ability Test (MeAT), and Mathematics Achievement Test (MAT). The LRAT comprised two sections: Section A gathered demographic data like class and identification number, while Section B contained ten multiple-choice questions (A-D), with each correct answer scoring one mark. This test was adapted from Tobin and Capie's Test of Logical Thinking (1981) and modified to focus on mathematics.

The MeAT also had two sections: Section A collected demographic information, and Section B consisted of 14 alphabet series of increasing length, from 2 to 8 digits, with each correctly filled series scoring 1, up to a total of 14. This test was adapted from Wechsler's Digit Span Test (2014) but used alphabets and required students to write backward to enhance the memory challenge.

The MAT underwent face and content validation, while the MeAT and LRAT were subjected to face validation only. The content validity of MAT was determined using a table of specifications based on Bloom's taxonomy, with weights assigned to six mathematics content areas and cognitive levels. Questions were drawn from the SSII Mathematics syllabus according to these weights.

Reliability coefficients for MAT, MeAT, and LRAT were 0.72, 0.87, and 0.98, respectively, calculated using the Kuder-Richardson 20 (K-R20) formula. Instruments were administered and collected for analysis. Data were analyzed using simple linear regression, with the coefficient of determination used to address the research questions. Hypotheses were tested



using regression t-tests, as the study involved one dependent and one independent variable.

## Results

**Table 1:** Regression analysis of the amount of variation in students’ achievement in mathematics that is accounted for by logical reasoning ability

Model	R	R Square	Adjusted R Square	Std Error of the Estimate
1	.404 <sup>a</sup>	.163	.161	7.66034

a. Predictors: (Constant), Logical Reasoning Ability

The result in Table 1 shows that there is a correlation coefficient of  $R = .404$ , with a coefficient of determination ( $R^2$ ) of  $.163$ , between students' achievement in mathematics and their ability to reason. This suggests that there is a favourable correlation

between pupils' mathematical proficiency and their capacity for reasoning. Furthermore, the coefficient of determination ( $R^2 = .163$ ) indicates that 16.3% of the diversity in students' math achievement may be explained by their capacity for logical reasoning.

**Table 2:** Regression t-test analysis of the amount of variation in students’ achievement in mathematics that is accounted for by logical reasoning ability”

Model		Unstandardized Coefficients		Standardized	T	Sig.
		B	Std. Error	Beta		
1	(constant)	14.316	.915		15.654	.000
	Logical Reasoning Ability	1.571	.187	.404	8.411	.000

a. Dependent Variable: Achievement

With  $t = 8.411$  and  $p = .000$ , Table 2 shows that there is a significant variation in students' mathematics achievement that may be explained by their capacity for logical thinking. The null hypothesis is rejected since

the p-value is less than the .05 significance level. Thus, it may be concluded that students' proficiency in mathematics is favourably predicted by their capacity for logical reasoning.

**Table 3:** Regression analysis of the amount of variation in students’ achievement in mathematics that is accounted for by memory ability

Model	R	R Square	Adjusted R Square	Std Error of the Estimate
1	.198	.039	.037	8.20964

a. Predictors: (Constant), Memory Ability

Table 3 shows that there is a link ( $R = .198$ , with a coefficient of determination ( $R^2$ ) of  $.039$ ) between students' achievement in mathematics and their memory. This implies that there is a favourable correlation between mathematics performance and

memory skills in students. Moreover, the coefficient of determination ( $R^2 = .039$ ) suggests that 3.9% of the variation in students' math achievement can be attributed to memory capacity.

**Table 4:** Regression t-test analysis of the amount of variation in students' achievement in mathematics that is accounted for by memory ability

Model	Unstandardized Coefficients		Standardized Coefficients			
	B	Std. Error	Beta	t	Sig.	
1	(constant)	31.702	2.758		11.493	.000
	Memory Ability	.844	.220	.198	3.844	.000

a. Dependent Variable: Achievement

Table 4 demonstrates that, with  $t = 3.844$  and  $p = .000$ , the difference in pupils' mathematics achievement explained by memory capacity is substantial. Since the null hypothesis is rejected, the  $p$ -value is less than .05. Thus, it may be concluded that students' achievement in mathematics is favourably predicted by their memory capacity.

### Discussion

The study found a positive correlation between students' logical reasoning ability and their mathematics achievement. The result further indicates that logical reasoning ability significantly enhances students' mathematics performance. This finding suggests that successfully performing mathematical tasks requires students to think and reason to arrive at solutions. This aligns with Ramganes and Reddy (2021), who found that a significant portion of students' academic performance in mathematics can be predicted by their logical reasoning ability. Additionally, the study supports Maiti (2017), who identified reasoning ability as a crucial factor correlated with mathematics achievement. Given that reasoning is essential for understanding and solving mathematical problems, these findings highlight the importance of logical reasoning in students' mathematics achievement. However, these results contrast with Ahmad, Shah, and Raheem (2020), who found no significant correlation between reasoning ability and academic achievement. This discrepancy could be due to differences in the cultural background, characteristics, and education levels of the study subjects.

The study also reveals a positive correlation between students' memory ability and their mathematics achievement. The findings show that memory ability significantly impacts students' mathematics performance, suggesting that effective functioning in mathematics requires the ability to retain information provided by the teacher. This is consistent with Blankenship, O'Neill, Ross, and Bell (2015), who

found that working memory contributes to performance in both mathematics and reading. Without the ability to store and recall mathematical formulas, axioms, laws, rules, and theorems, students would struggle to perform well in mathematics. Thus, the finding that memory ability significantly influences mathematics achievement is justified. However, this study's findings contradict those of Ishak et al. (2012), who found no significant correlation between working memory and academic performance. This contradiction could be due to factors such as the education level of the study subjects, with students at higher education levels potentially having a better ability to retain and recall information over extended periods.

### Conclusion

Based on the study's findings, it was concluded that reasoning ability significantly influences students' achievement in mathematics. This means that as students improve their logical reasoning skills, their performance in mathematics increases, and vice versa. In other words, reasoning ability enhances students' mathematics achievement. Additionally, it was concluded that memory ability significantly impacts students' mathematics achievement. Therefore, a student with strong memory ability tends to perform well in mathematics, and vice versa.

### Recommendations:

1. Teachers of mathematics should regularly assess their students' logical thinking and memorisation skills by assigning difficult homework and class work.
2. The government should recruit only professional/qualified mathematics teachers to teach mathematics in schools who have the full knowledge of how to engage the students in tasks that will improve their logical reasoning and memory abilities, so as to reduce the high rate of poor achievement in mathematics.



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