EFFECT OF METACOGNITIVE STRATEGY ON SELF-REGULATION AND ACADEMIC PERFORMANCE IN MATHEMATICS AMONG PUBLIC SENIOR SECONDARY SCHOOL, KADUNA STATE

KHADIJA SALEH
Department of Educational Psychology
Federal University of Education, Zaria
khadizasaleh221@gmail.com

Abstract

This study investigated the effect of metacognitive strategy on self-regulation and academic performance in mathematics among public senior secondary school students in Kaduna State, Nigeria. A quasi-experimental design involving pretest-posttest control groups was adopted. A total of 62 students participated, with the experimental group exposed to metacognitive strategy instruction while the control group received conventional teaching. Data were analyzed using Analysis of Covariance (ANCOVA). Findings revealed a statistically significant effect of the metacognitive strategy on both self-regulation ($F(1, 59) = 121.71$, $p < .000$) and academic performance in mathematics ($F(1, 59) = 124.73$, $p < .000$), with large effect sizes. This indicates that the intervention greatly enhanced students' ability to manage their learning and improved mathematics outcomes. It is concluded that integrating metacognitive strategies into instruction effectively boosts students' academic engagement and performance in mathematics. Based on these findings, it is recommended that educational psychologists conduct regular skill-building workshops counsellors integrate metacognitive training into academic support programs, collaboration between teachers and counsellors be strengthened and school authorities and policymakers support the inclusion of metacognitive strategies in curricula and teacher development initiatives.

Keywords: Metacognitive strategy, Self-regulation, Academic Performance

Introduction

Mathematics remains a cornerstone of national development and a fundamental subject within Nigeria's secondary school curriculum, playing a crucial role in fostering critical thinking, logical reasoning, and problem-solving abilities. Its importance is particularly pronounced in shaping students' future career paths in science, technology, engineering, and mathematics (STEM) disciplines. Despite its relevance, consistent reports have shown that students in Nigeria, especially those in Kaduna State, continue to perform poorly in mathematics. Results from standardized examinations, including the West African Senior School Certificate Examination (WAEC), reveal persistently low pass rates in the subject (Ogunleye et al., 2022). This academic underachievement poses significant threats to students' educational and professional aspirations, limiting their ability to compete globally in STEM-related fields.

The recurring poor performance has been attributed to several pedagogical and learner-centered factors, including over-reliance on teacher-centered instruction, rote memorization, lack of motivation, and limited student engagement in reflective learning practices (Akinwale & Oluwatoyin, 2021). Many students struggle to become independent learners, lacking the skills to regulate their own learning processes a key

component in academic success. This has underscored the need for innovative instructional strategies that empower students to take active roles in their learning, particularly through self-regulation and metacognitive development.

Metacognitive strategies a deliberate process's learners use to plan, monitor, and evaluate their understanding and performance have been widely recognized as effective tools for enhancing learning outcomes across subject areas (Flavell, 1979). In mathematics education, these strategies are especially useful due to the subject's abstract nature and problem-solving demands. Students who are trained to use metacognitive strategies become more adept at selecting appropriate methods, checking their work, adjusting strategies when stuck, and reflecting on what works or fails (Schunk & Greene, 2021). These skills foster deeper understanding, greater conceptual clarity, and improved academic performance.

Self-regulation, which refers to the learners' ability to control their cognitive, emotional, and behavioral activities to achieve learning goals, complements metacognitive strategy use (Zimmerman, 2002). A self-regulated learner sets goals, plans strategically, monitors progress, and reflects on learning outcomes. Unfortunately, research in Nigeria suggests that most secondary school students do not possess strong self-regulatory skills, thereby relying excessively on external guidance from teachers and parents (Akinwale & Oluwatoyin, 2021). This dependence impairs their ability to function independently when faced with complex mathematical tasks.

Several empirical studies have highlighted the efficacy of metacognitive strategies in enhancing both self-regulation and academic performance in mathematics. Adeyemi et al. (2023) conducted an experimental study involving 180 secondary school students across three Nigerian states. The results showed that students who received metacognitive training (such as self-questioning, reflection, and goal setting) performed significantly better in mathematics assessments than those in the control group. The study concluded that fostering metacognitive awareness contributes to deeper learning and better academic outcomes. Yusuf et al. (2022) conducted a quasi-experimental study in Kaduna State involving 120 senior secondary school students. The findings indicated that those exposed to metacognitive instructional techniques demonstrated enhanced self-regulation skills such as time management and self-monitoring and significantly outperformed their peers in mathematics problem-solving tasks. This underscores the relevance of metacognitive approaches in the local educational context. In a study by Akinwale and Oluwatoyin (2021), researchers examined self-regulation and mathematics achievement among 300 senior secondary school students in Lagos and Oyo States. The results revealed that students who demonstrated strong self-regulation skills, including reflective thinking and proactive planning, scored higher on mathematics achievement tests than their peers. The study emphasized the importance of equipping students with self-regulatory techniques. Okonkwo and Onuoha (2020) evaluated the effectiveness of metacognitive instruction on mathematics performance among 150 Nigerian secondary school students. Their study found that students who received metacognitive training were better able to identify their learning gaps and take corrective actions, leading to sustained academic improvement over a 12-week intervention period. In a large-scale study conducted in the United States, Schunk and Greene (2021) conducted a meta-analysis involving over 50 studies on metacognitive strategy training. Their results demonstrated a strong positive relationship between metacognitive strategy use and student achievement, particularly in STEM subjects. The authors argued that metacognitive interventions had the most significant impact when embedded within subject-specific instruction. Oladeji et al. (2021) carried out a mixed-methods study in Northern Nigeria involving both student surveys and teacher interviews. They

found that schools where mathematics teachers incorporated metacognitive strategies such as reflective journals, think-alouds, and strategic questioning observed improvements in both student engagement and test scores. The study emphasized the need for capacity-building programs for teachers to integrate these strategies effectively.

While the global and national literature supports the efficacy of metacognitive strategies in enhancing academic outcomes, there remains a paucity of localized research that focuses specifically on how these strategies affect self-regulation and mathematics performance among secondary school students in Kaduna State. Given the socio-cultural and systemic challenges unique to the region including resource constraints, large class sizes, and examination pressures there is a critical need to explore context-specific applications of metacognitive strategies.

The theoretical foundation of this study is grounded in Bandura's (1986) Social Cognitive Theory, which posits that learning occurs in a social context through the reciprocal interaction of personal, behavioral, and environmental influences. Metacognitive strategies align with this theory by emphasizing self-directed learning and reflective thinking. Additionally, Zimmerman's (2002) Self-Regulated Learning Theory serves as a guiding framework, illustrating how learners acquire, apply, and sustain metacognitive behaviors to achieve academic goals.

Statement of the Problem

Despite its importance, mathematics remains one of the most poorly performed subjects among senior secondary school students in Nigeria, particularly in Kaduna State (Ogunleye et al., 2022). The over-reliance on teacher-centered methods, students' lack of independent learning skills, and inadequate exposure to strategic thinking approaches contribute to this persistent underachievement. Many students struggle to take control of their learning, lacking the metacognitive and self-regulatory strategies necessary to succeed in mathematics.

Although prior studies have demonstrated the effectiveness of metacognitive strategy instruction in improving academic performance, few have specifically examined its impact on both self-regulation and mathematics outcomes within the Kaduna State context. This study seeks to investigate the effect of metacognitive strategies on self-regulation and academic performance in mathematics among public senior secondary school students in Kaduna State.

Objectives of the Study

1. To determine the effect of metacognitive strategy on students' self-regulation in mathematics among senior secondary school students in Kaduna State
2. To assess the effect of metacognitive strategy on students' academic performance in mathematics among senior secondary school students in Kaduna State

Research Questions

1. What is the effect of metacognitive strategy on students' self-regulation in mathematics among senior secondary school students in Kaduna State?
2. What is the effect of metacognitive strategy on students' academic performance in mathematics among senior secondary school students in Kaduna State?

Research Hypotheses

H_{O1} There is no significant effect of metacognitive strategy on students' self-regulation in mathematics among senior secondary school students in Kaduna State

H_{O2} There is no significant effect of metacognitive strategy on students' academic performance in

mathematics among senior secondary school students in Kaduna State

Methodology

The study adopted a quasi-experimental research design with a pre-test-posttest non-equivalent control group. This design is appropriate because it allows for the assessment of the effect of metacognitive strategy on self-regulation and academic performance while controlling for confounding variables such as prior knowledge and differing classroom dynamics. The population comprised all Senior Secondary School II (SSS II) students enrolled in public secondary schools in Kaduna State, Nigeria. This group is chosen because they are midway through their senior secondary education and possess foundational knowledge in mathematics, making them suitable for the intervention.

A sample of 62 students was selected from two schools using cluster sampling techniques. Kaduna State and were divided into two zones (North and Southern zone). One school was randomly selected from each zone, ensuring geographical representation using random sampling. Within each school, one intact class was used for experimental and control group. Experimental group consist of 30 students while control group consisted of 32 students.

Two instruments were for data collection; Self-Regulation Questionnaire (SRQ) an instrument used to assess students' self-regulation skills pre- and post-intervention. Items focuses on goal setting, self-monitoring, and self-reflection and Mathematics Performance Test (MAT), a 30-item multiple-choice test covering core topics in the SS II scheme of work to assess students' academic performance. These instruments were validated by experts from Mathematics Department, Federal University of Education Zaria, Barewa College Zaria and Educational Psychology and Counseling Department, Ahmadu Bello University, Zaria. The Cronbach's alpha reliability coefficient obtained after pilot testing was of 0.852 and 0.793, respectively.

The entire experiment took a period of 8-weeks metacognitive strategy training program in the Experimental Group. The program included activities such as self-questioning, goal setting, and reflective journaling, facilitated by trained teachers. In the Control Group, students received conventional instruction using the lecture method without metacognitive training. Analysis of Covariance (ANCOVA) was used to test the effect of metacognitive strategies on self-regulation and academic performance.

Results

H_{O1} There is no significant effect of metacognitive strategy on students' self-regulation in mathematics among senior secondary school students in Kaduna State

Table 1 ANCOVA Result on effect of metacognitive strategy on students' self-regulation in mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3042.467[a]	2	1521.233	68.049	.000	.698
Intercept	1068.071	1	1068.071	47.777	.000	.447
Group	2720.790	1	2720.790	121.708	.000	.674
Pretest	456.633	1	456.633	20.426	.000	.257
Error	1318.953	59	22.355			
Total	94346.000	62				
Corrected Total	4361.419	61				

a. R Squared = .698 (Adjusted R Squared = .687)

Table 1 result reveals a statistically significant effect of the metacognitive strategy on students' self-

regulation in mathematics, F(1, 59) = 121.708, p < .000, with a large effect size (Partial Eta Squared = .674). This indicates that the metacognitive strategy significantly improved students' self-regulation skills. Therefore, the null hypothesis is rejected.

H_{O2} There is no significant effect of metacognitive strategy on students' academic performance in mathematics among senior secondary school students in Kaduna State

Table 2: ANCOVA Result on effect of metacognitive strategy on students' academic performance in mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3693.002[a]	2	1846.501	70.369	.000	.705
Intercept	983.648	1	983.648	37.486	.000	.389
Presttest	866.710	1	866.710	33.030	.000	.359
Group	3272.824	1	3272.824	124.725	.000	.679
Error	1548.175	59	26.240			
Total	84231.000	62				
Corrected Total	5241.177	61				

a. R Squared = .705 (Adjusted R Squared = .695)

Table 2 result shows a statistically significant effect of the metacognitive strategy on students' academic performance in mathematics, F(1, 59) = 124.725, p < .000, also with a large effect size (Partial Eta Squared = .679). This means that the metacognitive strategy had a significant impact on enhancing students' mathematics performance. Hence, the null hypothesis is rejected.

Discussion of Findings

The findings of this study revealed that the metacognitive strategy had a statistically significant effect on students' self-regulation in mathematics. The ANCOVA results showed a significant difference between the experimental and control groups on posttest self-regulation scores, F(1, 59) = 121.71, p < .000, with a large effect size (Partial Eta Squared = .674). This means that the metacognitive strategy accounted for 67.4% of the variance in students' self-regulation outcomes. This finding aligns with the theoretical assertions of Zimmerman (2002) and Schunk and Greene (2021), who highlighted the role of metacognitive strategies in enabling learners to plan, monitor, and evaluate their learning activities. The improved self-regulation observed among students in the experimental group indicates that metacognitive instruction empowered them to manage their learning, sustain attention, and reflect on their problem-solving approaches. This supports the findings of Akinwale and Oluwatoyin (2021), who found that Nigerian students with strong self-regulation strategies outperformed their peers in academic tasks.

In addition, the study found a significant effect of metacognitive strategy on students' academic performance in mathematics. The ANCOVA revealed a statistically significant difference in mathematics achievement, F(1, 59) = 124.73, p < .000, with a large effect size (Partial Eta Squared = .679), accounting for 67.9% of the variance in performance scores. This result corroborates those of Adeyemi et al. (2023) and Yusuf et al. (2022), who reported that students taught using metacognitive strategies such as goal setting, self-monitoring, and reflection performed significantly better in mathematics. The present finding reinforces the idea that when students are guided to "think about their thinking," they become better equipped to grasp abstract mathematical concepts and solve problems more effectively.

The results also support the Social Cognitive Theory proposed by Bandura (1986), which emphasizes the

interplay between personal, behavioral, and environmental factors in learning. Metacognitive strategy instruction enhances students' belief in their capacity to control learning outcomes, aligning well with this theoretical framework. Moreover, the findings are consistent with Zimmerman's (2002) Self-Regulated Learning Theory, which outlines a cyclical process involving forethought (planning), performance (self-monitoring), and self-reflection. The success of the intervention suggests that students benefited from this cycle, resulting in improved academic engagement and outcomes.

The high proportions of variance explained in both self-regulation ($R^2 = .698$) and academic performance ($R^2 = .705$) further highlight the strength of metacognitive strategy as a pedagogical tool. These results advocate for a pedagogical shift away from traditional, teacher-centered methods toward student-centered approaches that promote metacognitive engagement, independence, and deeper learning especially in mathematics, a subject often regarded as difficult and abstract by many learners.

Conclusion

The study established that metacognitive strategy significantly enhance students' self-regulation and academic performance in mathematics. Teaching students how to plan, monitor, and evaluate their learning helps foster independence and improve learning outcomes, especially in challenging subjects like mathematics.

Recommendations

1. Educational psychologists should conduct periodic workshops to equip students with self-regulation and metacognitive skills that boost academic performance.
2. School counsellors should embed metacognitive strategy training such as goal setting and self-reflection into academic counselling programs to support struggling learners.
3. Counsellors and psychologists should collaborate with mathematics teachers to identify at-risk students and provide targeted interventions using metacognitive techniques.
4. School leaders and policymakers should promote the inclusion of metacognitive skill development in the mathematics curriculum and teacher training programs to ensure sustained implementation across schools.

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