



## The Effectiveness of Metacognition on Academic Achievement among Nigerian University Students

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### Abstract

The study investigated the effectiveness of metacognition on academic achievement among Nigerian University students. Correlation survey research design was adopted for the study. Two instruments; Students Think Aloud and Self-Regulation Learning Strategy Questionnaire (STASLSQ) and Mathematics Achievement Proforma (MAP) developed by the researchers were used for data collection. The instruments were face-validated by experts. The internal consistency reliability index of STASLSQ obtained using Cronbach Alpha was 0.93. Data collected were analyzed using simple linear and multiple linear regression analyses through SPSS version 26.0 as well as regression analysis through Process model 1 procedure IBM SPSS version 4.00 by Hayes (2018). The finding revealed 17% variation in students' academic achievement in Mathematics can be attributed to thinking aloud strategy, which is statistically significant. Again, 28% variation in students' academic achievement in Mathematics can be attributed to self-regulation strategy, which is statistically significant. Based on these findings, conclusions were drawn and recommendations were made that Students should be encouraged by Mathematics teachers to adopt metacognitive learning strategies when studying Mathematics to enhance their learning of the subject. Teachers should engage students with learning activities in mathematics that enable them to learn on their own using metacognitive strategies.

**Keywords:** Business Education, Metacognitive Learning Strategies, Mathematics, Think Aloud, Self-Regulation

### Introduction

Metacognitive learning strategies are essential to every learner. The strategies explain a person's ability to control his or her own thinking processes in problem solving during learning. According to Tayey (2018), metacognition is the process of consciously monitoring and regulating our own thought processes. A process in this context is a form of looking over your own shoulder by observing yourself as you work and thinking about what you are thinking. Metacognitive strategy is a strategy that employs students naturally, actively, and constantly observing metacognitive skills and behaviours, knowing how to learn effectively, being sensitive to strengths and weaknesses, and being efficient in planning, monitoring, and evaluating current learning (Abubakar & Ismail, 2020). Metacognitive learning strategies can therefore be seen in this study as the tactics for acquiring knowledge that encourages students' adoption of mental skills in the learning process.

The importance of learning through metacognitive learning strategy has become the latest trend and has become an innovation in instructional design to create active learning. Metacognitive learning strategies can provide satisfaction and learning experiences as well as encourage self-motivation during learning (Cera, Mancini, & Antionetti, 2013). The learning situation is clearly different from conventional learning, where students actively engage in constructing their knowledge through planning, monitoring, and evaluating self-learning during learning activities (Smith, 2013; Smith & Mancy, 2018). The activities in the metacognitive learning strategy will encourage students to discover, discuss, think, compare, predict, and even guide other students. Cooperation, relationships between students, and interaction with learning materials are the keys to the success of metacognitive learning strategies. Furthermore, the appropriate use of meta-cognitive strategies helps



individuals gain knowledge and intellectual abilities that guide and direct intellectual processes in learning (Lai, 2011; Knox, 2017). Going by the foregoing, metacognitive learning strategies may be efficacious in mathematics instruction.

Metacognitive learning strategy that could enhance students' achievement in mathematics is thinking aloud. As opined by Drew (2022), thinking aloud refers to verbalising one's thoughts while completing a task. According to Drew, during problem solving, when thinking aloud, students would keep on talking, speaking out loud whatever thoughts came to mind, while performing the task at hand. One major advantage of the strategy is being able to capture the individual's immediate thoughts while learning (Jacobse & Harskamp, 2012). Thus, Boonen, Van Wesel, Jolles, and Der Scoot (2014) asserted that the strategy is essential in problem solving tasks. On this note, one could assume that the strategy is capable of predicting students' achievement in Mathematics. This could be verified by studying the predictive power of thinking aloud as a metacognitive strategy on students' achievement in Mathematics.

Thinking aloud refers to verbalizing one's thoughts out loud while completing a task. Thinking aloud during problem solving means that the subject keeps on talking, speaking out loud whatever thoughts come to mind, while performing the task at hand. Unlike the other techniques for gathering verbal data, there are no interruptions or suggestive prompts or questions. One of the major advantages of using the think-aloud method is being able to capture the individual's immediate thoughts (Jacobse & Harskamp, 2012), which is important in understanding students' problem-solving processes. Teachers should promote the habit of thinking aloud when learners solve problems, and this would help learners develop their thinking skills. Think-aloud skills are connected with good reading comprehension skills as well as more developed reading comprehension strategies (Lau, 2006, cited in Björn et al., 2019). Therefore, literacy skills need to be taken into account when examining the effects of the think-aloud intervention on mathematics word problem-solving skills (Boonen, Van Wesel, Jolles, & Der Scoot, 2014). This strategy is essential in problem solving; hence, it might be potent in predicting students' achievement in mathematics if promoted in the classroom.

Self-regulation is another potential metacognitive strategy that could predict students' achievement in Mathematics. As defined by Kaur

(2017), self-regulation refers to one's awareness of his or her understanding and performance of a task. According to Monk and Silman (2013), proper self-regulation is likely to contribute positively to students' learning outcomes. Self-regulation is also considered as one's ability to engage in periodic self-testing while learning is taking place (Rani & Govil, 2013). Operationally, self-regulation is defined in this study as students' ability to intermittently engage in self-guidance during studying and learning of Mathematics. This explains the need for learners to understand and regulate their own thinking processes and actions in order to resolve the various tasks assigned to them. Thus, it is necessary to find out the amount of variation in students' achievement in Mathematics that could be attributed to their self-regulation metacognitive strategy.

The need for regulating one's own learning has emerged due to the value placed on education, and it has underlined self-regulation learning. Self-regulated learning is one's ability to develop knowledge, skill, and attitude to be able to self-control in the learning process with full responsibility and perseverance in fulfilling learning demands, supported by a positive belief in doing it despite the difficulty, and to direct his or her cognition and motivation to achieve the learning goal successfully (Loyens, Magda, & Rikers, 2008). The term self-regulated learning can be used to describe learning that is guided by metacognition (thinking about what other people think), strategic action (planning, monitoring, and evaluating personal progress toward a standard), and motivation to learn (Inggriyani & Hamdani, 2018). Self-regulation is an integrated learning process that consists of behaviour growth that affects students learning. Therefore, someone who possesses self-regulation has the opportunity to take on challenging tasks, practice their learning, develop a deep understanding of the learning material, and expend his or her effort to generate academic success. The learning process is planned and adjusted according to the students' objectives, so changes will be made in the learning situation. Students with self-regulated learning have an awareness of their performance (Fauzi & Widjajanti, 2018). Based on that, it is undoubtedly true that self-regulated learning is strongly related to academic achievement. Hence, academic achievement will increasingly enhance if self-regulation learning is good.



## Theoretical Framework

Theoretically, the findings of this study added credence to Flavell's (1987) Theory of Metacognition and Bandura's (1986) Social Cognitive Theory of Learning, upon which the study is anchored. Precisely, the findings of this study lend support to Flavell's theoretical notion that maladaptation in knowledge, learning experiences, and strategies combines to give rise to an unhelpful pattern of thinking that leads to poor learning outcomes and other psychological problems. Flavell also posited that most people usually have thoughts about being a failure, but that individuals would respond to these thoughts in different ways depending on their awareness of their thinking. All these are related to students' metacognitive strategies which are the focus of this study.

The general purpose of this study was to investigate metacognitive learning strategies as predictors of senior secondary school students' academic achievement in Mathematics in Abuja Municipal Council of the Federal Capital Territory (FCT), Abuja, Nigeria. The following issues were raised and addressed in this study;

1. What is the amount of variation in students' academic achievement in Mathematics that can be attributed to thinking aloud strategy?
2. What is the amount of variation in students' academic achievement in mathematics that can be attributed to self-regulation strategy?

## Methods

The study adopted a correlational research design. According to Nworgu (2015), this type of design seeks to establish what relationship exists between two or more variables and also indicates the direction and magnitude of the relationship between the variables. Accordingly, since the present study sought to establish the amount of variation in students' academic achievement in Mathematics that can be attributed to their metacognitive learning strategies (thinking aloud & self-regulation), which are the predictor or independent variables, the design was therefore considered appropriate for this study. The sample for this study comprised 357 senior secondary two (II) students involving multistage sampling procedure. This sample size is based on Cohen, Mannion and Morrison's (2018, p.206) criteria for choosing a sample size from a population that ranges from 5, 000- 6,999 at 95% confidence level.

Two instruments developed by the researchers were used for data collection in this study. They are: Students' Think Aloud Self-Regulation Learning Strategy Questionnaire (STALSQ) and Mathematics Achievement Proforma (MAP). The STALSQ have two (2) sections; section A and section B. Section "A" elicits personal information of the respondents. The section "B" has two clusters (I & II), Cluster I have 6 items that elicited data on students' thinking aloud strategy and Cluster II have 5 items that elicits data on students' self-regulation strategy. The students expressed their level of agreement or otherwise to each of the items modeled on a modified four (4) point Likert-type scale with response options such as Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) with numerical values or points of 4, 3, 2, and 1 respectively. Mathematics Achievement Proforma (MAP) is used to obtain the students' achievement scores in Mathematics from the sampled secondary schools.

The face validation of the instruments was done by experts, one each from the fields of: Educational Research, Measurement & Evaluation unit; Mathematics Education unit; and Educational Psychology unit, all from the Faculty of Education, University of Nigeria, Nsukka. In addition to face validation, the construct validity of the Students' Think Aloud and Self-Regulation Learning Strategy Questionnaire (STALSQ) was established using factor analysis. This was done by first administering copies of the initial face-validated version of the questionnaire on a sample of 50 SSII Mathematics students. After administration of the questionnaires, the responses of the students were then subjected to factor analysis using the Principal Component Analysis (PCA). Three factors were extracted based on the Scree Plot generated by the SPSS software. The total variance in the scale explained by the three factors extracted after employing Varimax rotation technique was 63.98%, which is quite substantial. In the selection of the valid items using the "Rotated Component Matrix" generated from the analysis, the researchers adopted Meredith's (1969) benchmark value of 0.35 and above for substantive factor loadings for valid items. As stated by Meredith, only factor loadings of 0.35 and above, on one factor should be considered substantive and valid for an item.

The reliability of the STALSQ was determined after trial-testing the final version of the instrument on thirty (30) SSII students randomly sampled from two Public Secondary Schools in Abaji area council. The schools were chosen because they are

within FCT, Abuja and the area is not involved in the actual study. The internal consistency of the instrument was determined using the Cronbach Alpha method of estimating reliability through Statistical Package for Social Sciences version 24 (SPSS 24.0). The Cronbach Alpha method was employed because it applies to instruments that involve polytomous scoring (items with no right or wrong option) such as the STASLSQ used for this study. The reliability estimates obtained for the STASLSQ was 0.79.

Data collected were analyzed using simple linear and multiple linear regression analyses through SPSS version 26.0 as well as regression analysis through Process model 1 procedure IBM SPSS version 4.00 by Hayes (2018). The correlation coefficients (R) and coefficient of determination ( $R^2$ ) obtained from simple linear regression analysis was used to answer research questions 1 and 2. The null hypotheses were tested using regression ANOVA. All the hypotheses were tested at 0.05 level of significance. The decision

rule for testing the hypotheses is that: Reject the null hypothesis ( $H_0$ ) if the exact or associated probability to the test statistic is equal to or less than 0.05 level of significance, otherwise do not reject the null hypothesis.

### Results

Result in Table 1 shows the regression analysis for the amount of variation in students' academic achievement in Mathematics that can be attributed to thinking aloud strategy. The result shows that when the scores from the responses of students on thinking aloud strategy were correlated with their academic achievement scores in Mathematics, a correlation coefficient (R) of 0.41 with associated coefficient of determination ( $R^2$ ) of 0.17 were obtained. This coefficient of determination ( $R^2$ ) of 0.17 implies that 17% variation in students' academic achievement in Mathematics can be attributed to thinking aloud strategy.

**Table 1.** Regression Analysis of the variation in students' academic achievement in Mathematics that can be attributed to thinking aloud strategy

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change
						F	df1	df2	
1	.406 <sup>a</sup>	.165	.163	7.915	.165	78.644	1	355	.000

a. Predictors: (Constant), Planning Ahead Strategy; R = Correlation coefficient

Result in Table 2 reveals that the variation in students' academic achievement in Mathematics that can be attributed to the think-aloud strategy is statistically significant ( $F(1, 356) = 70.147, p = .000$ ). This is due to the fact that the associated probability value of .000 when compared with 0.05 level of significance at which the hypothesis was being tested was found to be significant because .000 is less than

0.05. Consequently, the null hypothesis one ( $H_{01}$ ) was rejected, and inference drawn was that there is a statistically significant variation in students' academic achievement in Mathematics that can be attributed to the think-aloud strategy. That is to say, the think-aloud strategy accounts for a considerable variation in students' academic achievement in Mathematics.

**Table 2.** Regression ANOVA Test of Significance for the variation in students' academic achievement in Mathematics that can be attributed to think-aloud strategy

Model		Sum of Squares	df	Mean Square	F	Sig.	Dec.
1	Regression	4926.641	1	4926.641	70.147	0.000	S
	Residual	24932.796	355	70.233			
	Total	29859.438	356				

Note: df = degree of freedom, F= ANOVA Statistic, S = Significant ( $\alpha < 0.05$ )

The result in Table 3 shows the regression analysis for the amount of variation in students' academic achievement in Mathematics that can be attributed to self-regulation strategy. The result indicates that when the scores from the responses of students on self-regulation strategy were correlated with their academic achievement scores in

Mathematics, a correlation coefficient ( $R$ ) of 0.53 with associated coefficient of determination ( $R^2$ ) of 0.28 were obtained. This coefficient of determination ( $R^2$ ) of 0.28 implies that 28% variation in students' academic achievement in Mathematics can be attributed to self-regulation strategy.

**Table 3.** Regression Analysis of the variation in students' academic achievement in Mathematics that can be attributed to self-regulation strategy

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change
						F	df1	df2	
1	.534 <sup>a</sup>	.285	.283	6.112	.285	158.707	1	355	.000

a. Predictors: (Constant), Planning Ahead Strategy; R = Correlation coefficient

The result in Table 4 also indicates that the variation in students' academic achievement in Mathematics that can be attributed to self-regulation strategy is statistically significant ( $F(1, 356) = 141.560, p = .000$ ). This is because the associated probability value of .000 when compared with 0.05 level of significance at which the hypothesis was being tested

was found to be significant since .000 is less than 0.05. Accordingly, the null hypothesis two ( $H_{02}$ ) was rejected, and the conclusion drawn was that there is a statistically significant variation in students' academic achievement in Mathematics that can be attributed to self-regulation strategy.

**Table 4.** Regression ANOVA Test of Significance for the variation in students' academic achievement in Mathematics that can be attributed to self-regulation strategy

Model		Sum of Squares	df	Mean Square	F	Sig.	Dec.
1	Regression	5929.399	1	5929.399	141.560	0.000	S
	Residual	14869.579	355	41.886			
	Total	20798.978	356				

Note: df = degree of freedom, F = ANOVA Statistic, S = Significant ( $\alpha < 0.05$ )

## Discussion

This study also revealed that 17% variation in students' academic achievement in Mathematics can be attributed to thinking aloud strategy. Furthermore, it was revealed that there is a statistically significant variation in students' academic achievement in Mathematics that can be attributed to the think-aloud strategy. These findings corroborate previous findings by Abdul Kani and Shahrill (2015) whose study showed that applying the thinking aloud problem-solving strategy (TAPPS) in mathematics significantly led to improvement in students' problem-solving behaviour, especially in understanding the problem. The findings

are also in agreement with previous findings by Sudiati, Hanapi, and Bugis (2018) who investigated the effectiveness of the think-aloud strategy on students' reading achievement in Negeri Waplau, Indonesia and reported that there was a significant effect of thinking aloud strategy on students' achievements. In the same vein, the finding to a large extent lends support to the outcome of the study by Björn et al. (2019), which showed improvement in the efficacy of correct answers or attempted mathematics word problem items among students due to thinking aloud learning strategy. Thus, the above finding of this study could be so because the



thinking aloud usually involves verbalising one's thoughts while completing a task. When doing so, students would keep on talking, speaking out loud whatever thoughts comes to their mind, and this may help them to concretize learning and recall such learning after a period of time. Again, one major advantage of the strategy is being able to capture the individual's immediate thoughts while learning. All these may have accounted for the significant variation in students' academic achievement in Mathematics that can be attributed to the think-aloud strategy as shown by this study.

The findings this study also showed that 28% variation in students' academic achievement in Mathematics can be attributed to self-regulation strategy. It further revealed that there is a statistically significant variation in students' academic achievement in Mathematics that can be attributed to self-regulation strategy. This means that self-regulation strategy accounts for a considerable difference in students' academic achievement in mathematics. These findings are substantially consistent with previous findings by Inggriyani and Hamdani (2018) who investigated on self-regulated learning in relation to academic achievement among elementary school students in Bandung, Indonesia and the result showed that there is significant correlation between self-regulated learning and academic achievement among elementary school students. The findings corroborate with previous findings by El-Adl and Alkharusi (2020) who investigated the relationships between self-regulated learning strategies and mathematics achievement and disclosed that there exists a statistically positive relationships between self-regulated learning and students' academic achievement. Furthermore, the findings also affirm the report by Duru and Okeke (2021) who studied self-regulated learning skill as a predictor of mathematics achievement and the result showed that self-regulated learning skill predicts students' achievement in mathematics. The finding could be so because self-regulation strategy is based on one's awareness of his or her understanding and performance of a task. Thus, proper self-regulation is likely to contribute positively to students' learning outcomes as the strategy increases students' ability to intermittently engage in self-guidance when studying and learning of a subject like Mathematics. Students who therefore adopt self-regulation learning strategy are likely to be more aware of their understanding, strengths, weaknesses, and performance than those who do not. Hence, the finding that a significant amount of

variation in students' achievement can be due to self-regulation strategy can be adduced to be in order.

### Conclusion

The study revealed that metacognitive learning strategies such as thinking aloud and self-regulation separately and compositely account for a significant variation in students' academic achievement in mathematics. In essence, the strategies contribute substantially to students' academic achievement in mathematics. From these findings of the study, it is therefore concluded that metacognitive learning strategies contributes greatly to students' academic achievement in Mathematics and as such they need to be put into consideration in the learning of the subject. Based on the findings of the study, the following recommendations are made:

1. Students should be encouraged by Mathematics teachers to adopt think aloud learning strategies when studying Mathematics to enhance their learning of the subject.
2. Teachers should engage students with learning activities in mathematics that enable them to learn on their own using metacognitive strategies.

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