

EFFECT OF METACOGNITION ON ACHIEVEMENT AND RETENTION IN BUILDING DRAWINGS AMONG UNIVERSITY STUDENTS

O. D. Alawode¹, P. S. Yaduma², H. Bello³ and A. A. Deba⁴

¹Departments of Industrial and Technology Education (Building Technology education), Federal University of Technology Minna

^{2,3 & 4} Department of Vocational and Technology Education, Faculty of Technology Education, Abubakar Tafawa Balewa University, Bauchi

Corresponding Email: dolapoalawode@futminna.edu.ng

ARTICLE INFORMATION

Received: 09th February, 2025

Accepted: 13th March, 2025

Published: 18th April, 2025

KEYWORDS: Metacognition, achievement, retention, building drawings

PUBLISHER: Empirical Research Institute of Nigeria - (ERIN)

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).



<http://creativecommons.org/licenses/by/4.0/>

ABSTRACT

Metacognition is regarded as a fundamental skill influencing cognitive performance and learning in domains. It is a higher order thinking involving active control over the cognitive processes engaged in learning. Therefore, integrating metacognition into instructional strategy has gained attention for its potential to enhance academic achievement and retention. This study investigated the effect of metacognition on achievement and retention in building drawings among university students. The study determined the achievement of students taught using metacognitive instructional strategies against demonstration method and determined the retention of students taught using metacognitive instructional strategies against demonstration method. Two research questions, two null hypotheses and effect size measures guided the study. A quasi-experimental design with two intact class groups was adopted. The sample consisted of 245 students from two federal and two state-owned universities chosen through simple sampling techniques. The findings revealed that students taught using metacognitive strategies significantly outperformed those taught through demonstration methods in both achievement and retention. The experimental group established consistent performance gains and better knowledge retention, with effect size analysis indicating large to very large effects, underscoring the practical significance of the strategy. These findings accentuate the importance of adapting metacognitive strategies as an innovative approach to teaching building drawings among building technology education students in the universities.

Introduction

Metacognition, often described as higher order thinking" plays a crucial role in learning and cognitive

development. It involves the awareness and regulation of one's cognitive processes, enabling learners to plan, monitor, and evaluate their learning strategies (Mekala and Radhakrishnan, 2019). The concept of metacognition is deeply rooted in constructivist learning theories, particularly those advanced by Jean Piaget, Jerome Bruner, and Lev Vygotsky. These scholars laid the foundation for understanding how learners construct knowledge, emphasizing active engagement, self-regulation, and the social context of learning.

The integration of metacognition into instructional strategies is therefore a direct application of constructivist principles. Metacognition in terms of 'higher order thinking is for students to actively control the cognitive processes engaged in thinking and acquiring knowing' (learning). The definition of metacognition later modified as learners' awareness of their own knowledge and their ability to understand, control and manipulate skills (Padmanabha, 2020). This description of metacognition supports the effect of metacognitive instructional strategies in enhancing students' academic achievement, particularly in building drawings, where visualization and problem-solving skills are crucial (Özçakmak, Köroglu, Korkmaz and Bolat, 2021).

Metacognitive instructional strategy is an ordered processes used to control and monitor student's own cognitive activities and to ensure that a cognitive goal in solving problem and other engagements have been met in the course of learning. Tobias and Everson's (2009) hierarchical model of metacognition provide a structured framework for implementing metacognitive instructional strategies. According to this model, metacognitive learning involves four key components: planning, selecting strategies, evaluating learning, and knowledge monitoring. These components enable learners to control their cognitive processes effectively, improving their ability to regulate learning experiences. The general perception of metacognition in instruction is strongly connected to self-regulatory, self-identity and reflection as a process for achieving self-awareness as a learner. Students can only be aware of their learning strategy consciously or unconsciously if effective instructional strategy such as metacognitive instructional strategy is employed during teaching and learning process (Jody, Diana, Megan, Amy, Jessica, Matthew & Manuela, 2019).

Teaching building drawings as a technical oriented course, involves: connection, construction, interpretation of drawings and techniques that needs metacognitive strategy to improve building drawing concepts. building drawings is synonymous as architectural drawings in some universities offering building technology education and other tertiary institutions that deal with drawings and its interpretation (National Universities Commission (NUC), 2021). Building drawings comprise of presentation of drawings (isometric, oblique and perspective), projection (plan, block plan, site plan, and elevations), section and model with the use of drawing instruments, tools and equipment. It requires skills that involve the manipulation of drawing instruments to construct jointed lines, skills that can navigate thinking from concrete knowledge into abstract knowledge towards a memorable and interesting course.

Metacognitive strategy is flexible when permeate into learning process to develop and enhance students thinking processes that will last for long time. Absorption of knowledge gained is what technology education students need to activate for academic achievement. If information is to be retained and retrieved for use over a period of time, it must be stored in long-term memory as schemata (Drigas and Mitsea, 2021). Hence, memory is essential for individuals to remember experiences and use them to respond to future events (retention). Students' retention is a process of ensuring student success. Therefore, understanding retention and what facilitates it can help teachers select strategy like that of metacognitive strategy to improve the retrieval of information among students. Building technology education students' retention can be retained and sustained for over a period of time if a memorable learning strategy of metacognitive strategy components

are employed during and after teaching and learning subjects (Padmanabha, 2020). Technology education students need effective instructional strategy of metacognitive strategy to improve on the existing teaching-learning strategies towards building drawings knowledge. Hence, this study tends to investigate the effect of metacognition on achievement and retention in building drawings among university students.

Statement of the Problem

The challenge of teaching subject concepts has often been linked to the instructional methods employed by educators, among other factors. Samaresh (2017); Yildirim and Ortak (2021) suggest that traditional teaching strategies may fail to engage students, leading to a lack of interest in the subject matter. Similarly, Padmanabha (2020); Eşref and Cevat (2021) have highlighted that low academic achievement among students may stem from the use of inappropriate instructional strategies, students' inability to self-regulate their learning, and a lack of understanding of how to apply learning strategies effectively when needed.

The discrepancies in students' awareness of their own learning abilities appear to be a critical gap in the teaching and learning of building drawings at the university level. This gap underscores the need for alternative instructional methods that can better enhance students' understanding and retention of building drawings concepts. Despite the recognized importance of metacognitive strategies in education, there has been little to no empirical research testing the effectiveness of these strategies within technology education courses at the university level. In response to this gap, the present study aims to determine the effect of metacognition on achievement and retention in building drawing among university students.

Aim and Objectives of the Study

The aim of this study is to determine the effect of metacognition on achievement and retention in building drawings among university students. Specifically, the study seeks to:

1. Determine the academic achievement of students taught building drawings using metacognitive strategy and demonstration method
2. Determine the effect of metacognitive instructional strategy on students' retention in building drawings.

Research Questions

The following research questions were in order to achieve the objectives of the study

1. What is the academic achievement of students taught building drawings using metacognitive strategy and demonstration method?
2. What is the effect of metacognitive strategy on students' retention in building drawings as against those taught with demonstration method?

1.5 Research Hypotheses

Based on the research questions drawn for the conduct of this study, the following null hypotheses were formulated and tested at 0.05 significance levels:

- H₀₁:** There is no significant effect in the academic achievement of students taught building drawings using metacognitive strategy against demonstration method.
- H₀₂:** There is no significant effect in the retention of students taught building drawings using metacognitive instructional strategy and those taught using demonstration method.

METHODOLOGY

The study adopted quasi-experimental design. This design involved the use of two intact class groups (experimental and control). It, therefore, utilized the nonequivalent, non-randomized control group design. The total sample size for this study was 245 building technology education students were sampled for the study. Purposive non-probability sampling was used to select all the universities offering technology education as suggested by (Salendab and Laguda, 2023). Using simple random sampling techniques, two federal and two state-owned universities were selected for the study among the universities offering building technology education. The two federal universities were considered as a single experimental group while the two state-owned universities were considered as a single control group respectively.

The instruments used for data collection are Building Drawings Achievement Test (BDAT) comprised of four theory questions covering the contents of floor plan, elevations, cross - section and roof plan. The face and content validity were employed along with theoretical alignment for the instrument and experts validated the instruments. Reliability of ADAT was determined by the test-retest method. The pilot testing of the instruments was conducted to 15 students of final year building technology education students of another university that was not part of the study. Cronbach Alpha (α) was used to establish the internal consistency of the ADAT. The reliability coefficient of the instrument obtained was 0.84.

The concept of metacognitive strategy, modified version of Tobias & Everson (2009) Metacognitive Strategy Teaching Model (MSTM) was adapted. The treatment involves 5 stages: knowledge monitoring; readiness; selecting strategy; problem solving; reflection phase. Two weeks after, Building Drawing Achievement Test (BDAT) was re-administered to assess students' retention. Descriptive statistics in form of mean and standard deviation was deployed to address the research questions. Hypotheses were tested using an independent sample t-test and effect size using Cohen's d, Glass's delta, and Hedges' g for the study. An independent samples t-test was used for hypotheses to compare the mean scores of the experimental and control groups research questions. The significance level was set at $p < 0.05$, meaning that any p-value below 0.05 was considered statistically significant, indicating a meaningful difference between the groups. The study also analyzed the effect sizes for research questions to determine the magnitude of effect observed between groups. The interpretation of these effect sizes follows conventional benchmarks: small effect: $0.2 \leq d < 0.5$, medium effect: $0.5 \leq d < 0.8$ and large effect: $d \geq 0.8$.

Results

Research question 1: *What is the academic achievement of students taught architectural drawing using metacognitive strategy and demonstration method?*

Table 1: Descriptive statistic of the academic achievement means effect of students taught building drawings using metacognitive strategy and demonstration method

Variable	Group	N	\bar{x}	σ	Mean effect
Post-test	Experimental	65	67.37	6.276	8.01
	Control	180	59.36	5.907	
	Total	245			

Note: N= Number of Respondents, \bar{x} = Mean, σ = Standard Deviation

The table 1 revealed that the experimental group ($\bar{x} = 67.37$, $\sigma = 6.28$) outperformed the control group ($\bar{x} = 59.36$, $\sigma = 5.91$) with a mean effect of 8.01. The lower standard deviation in the experimental group indicates a more consistent performance compared to the control group. These results suggest that metacognitive instructional strategies positively have more effect on students' academic achievement in building drawings.

Research question 2: *What is the effect of metacognitive strategy on students' retention in building drawings as against those taught with demonstration method?*

Table 2: Descriptive statistic of the retention means effect of students taught building drawings using metacognitive strategy and demonstration method

Variable	Group	N	\bar{x}	σ	Mean Effect
Post-post-Test	Experimental	65	73.75	7.634	4.26
	Control	180	59.49	7.605	
	Total	245			

Note: N= Number of Respondents \bar{x} = Mean, σ = Standard Deviation

Table 2 presents the experimental group, taught with the metacognitive strategy, achieved a higher post-post-test mean score ($\bar{x} = 73.75$, $\sigma = 7.63$) than the control group ($\bar{x} = 59.49$, $\sigma = 7.61$), indicating a mean effect of 4.26. This significant difference suggests that the metacognitive strategy effectively enhanced students' retention of building drawing concepts over time.

Hypothesis 1: *There is no significant difference in the academic achievement of students taught building drawings using metacognitive strategy against demonstration method.*

Table 3: Independent samples t-test for academic achievement of students taught building drawings using metacognitive strategy and those taught using demonstration method.

Levene's Test for Equality of Variances								
Variable	Groups	N	F	Sig.	t-value	\bar{x}	σ	Sig. (2-tailed)
Pre-test	Experimental	65	.001	.981	9.218	67.37	6.276	.000
	Control	180				59.36	5.907	

Table 3 shows the results of an independent samples t-test comparing the academic achievement of students taught building drawings using the metacognitive instructional strategy against the traditional method. Levene's test for equality of variances indicated that the assumption of equal variances was met ($F = 0.001$, $p = 0.981$). The t-test revealed a statistically significant difference in academic achievement between the experimental group ($\bar{x} = 67.37$, $\sigma = 6.28$) and the control group ($\bar{x} = 59.36$, $\sigma = 5.91$) with a t-value of 9.218 and a p-value of 0.000 ($p < 0.05$), suggesting that the metacognitive instructional strategy significantly improved students' academic achievement in building drawing compared to the traditional method.

Hypothesis 2: *There is no significant effect in the retention of students taught building drawings using metacognitive instructional strategy and those taught using demonstration method.*

Table 4: Independent samples t-test for effect in the retention of students taught building drawings using metacognitive strategy and that those taught using demonstration method.

		Levene's Test for Equality of Variances						
Variable	Groups	N	F	Sig.	t-value	\bar{x}	σ	Sig. (2-tailed)
Retention	Experimental	65			12.944	73.75	7.634	
	Control	180	1.076	.301		59.49	7.605	.000

The independent samples t-test in Table 4 showed a statistically significant difference in the retention of students taught building drawings using the metacognitive instructional strategy (experimental) ($\bar{x} = 73.75$, $\sigma = 7.634$) compared to those taught using the demonstration method (control) ($\bar{x} = 59.49$, $\sigma = 7.605$), with a t-value of 12.944 and a p-value of 0.000 ($p < 0.05$). Null hypothesis two was, therefore, rejected. The finding indicates that the metacognitive instructional strategy was more effective in enhancing students' retention of architectural drawing concepts.

Effect size

The results of effect size, its interpretation and hypothesis implication are below:

Research question one:

The results of effect size for Cohen's $d = 1.403508$, Glass's $\delta = 1.456364$, Hedges' $g = 1.380421$ are the results of effect size of RQ 1. All values indicate a large effect. This suggests a substantial effect between the groups. This implies that, if the hypothesis predicted a difference, it would be supported by the data, indicating a strong effect of the variable tested.

Research question two:

The results of effect size for Cohen's $d = 1.87151$, Glass's $\delta = 1.867959$, Hedges' $g = 1.873198$ are the results of effect size of RQ 2. These values indicate a very large effect. There is a strong and meaningful difference between the groups. The hypothesis would be strongly supported, indicating a powerful effect of the variable.

Discussion of the Findings

The findings of research question one and its null hypothesis indicated that metacognitive instructional strategy was more effective in improving students' academic achievement in building drawings

compared to the demonstration method. The findings of this study concurred with existing literature, such as the studies conducted by Tachie, (2019), Agwu and Okigbo (2024); Langdon, Botnaru, Wittenberg, Riggs, Mutchler, Syno and Caciula (2019), who examined the effect of metacognitive strategy instruction in mathematical problem solving and students' achievement among other different dependent variables affirmed that the metacognitive teaching strategy perform better than demonstration method. Similarly, Eze, Obidile Akamobi (2019); Jody, et al. (2019) also in agreement in their studies that metacognitive teaching strategy performed better than demonstration method. The results indicated that teaching with metacognition strategies is more effective to increase the achievement of students in mathematics course and the result showed that metacognition strategies is significantly effective than demonstration method.

The findings of research question two and its null hypothesis revealed that, there was a statistically significant effect in the retention of students taught building drawings using metacognitive instruction strategies and those taught using demonstration method in favour of experimental group. The findings in this study are in agreement with the findings of Adeniji, Ameen, Dambatta, and Orilonise (2018); Yildirim and Ortak (2021) who conducted a study on relative effectiveness of constructivism and meta-learning teaching methods on academic achievement and retention of basic electricity among technical college students; studied the effects of the authentic learning approach in social studies on academic achievement, retention of knowledge, and attitude towards the course. The studies showed that metacognitive strategy learning had a significant effect on students' retention ability against demonstration method. Likewise, Radmehr and Drake (2020) assessed the impact of a student's motivation and beliefs about calculus and their ability to retain mathematical skills after having practiced and developed metacognitive skills. The results of the study showed that there is a positive correlation between learning metacognitive skills and retaining content also, there is significant different among the variables which is in line with the present study

Conclusion

Introducing a new method or alternative means of teaching-learning building drawings within the domain of building technology education as a means of innovation and novelty cannot be over emphasized for academic achievement. This study examined the effects of metacognition on achievement and retention in building drawings among university students. It is important to know that metacognitive strategy puts emphasis on how students can plan, monitor and regulate their learning processes in order to achieve academic goal. The statistical analysis revealed that students in the experimental group, who received explicit instruction in metacognitive strategies, outperformed those in the control group. Likewise, the findings confirm that teaching through metacognitive instructional strategies significantly enhances students' retention ability, enabling them to recall and apply learned concepts more effectively. Therefore, the results demonstrate that metacognitive strategies are both teachable and learnable to improve academic achievement and retain and retrieve prior knowledge among building technology education students.

REFERENCES

- Agwu, F. A., and Okigbo, E. O. (2024). Effect of metacognitive instructional strategy on secondary school students' academic achievement in geometry in Idemili north local government area. *UNIZIK Journal of STM Education*, 7(1), 43-54.
- Drigas, A., and Mitsea, E. (2021). 8 Pillars X 8 Layers Model of Metacognition: Educational Strategies, Exercises & Trainings. *International Journal of Online & Biomedical Engineering*, 17(8), 115-134.
- Erkan C. (2019), The Instruction of Writing Strategies: The Effect of the Metacognitive Strategy on the Writing Skills of Pupils in Secondary Education

- Eşref, A. and Cevat, E. (2021). The effect of phenomenon-based learning approach on students' metacognitive awareness. *Academic Journal of Educational Research and Reviews*. Vol. 16(5), pp. 181-188.
- Eze T.I., Obidile J. I., Akamobi O. G. (2019). Relative effectiveness of constructivism and meta-Learning teaching methods on male and female students' academic achievement and retention in basic Electricity in Technical Colleges. *Journal of Education and Practice*. www.iiste.org. ISSN 2222-1735 (Paper), ISSN 2222-288X (Online), Vol.10, No.33, 201.
- Jody, L., Diana, T. B., Megan, W., Amy, J. R., Jessica, M. Matthew and Manuela, C. C. (2019). Examining the effects of different teaching strategies on metacognition and academic performance. *Adv Physiol Educ* 43: 414–422, 2019; doi:10.1152/advan.00013.2018.
- Langdon, J., Botnaru, D. T., Wittenberg, M., Riggs, A. J., Mutchler, J., Syno, M., & Caciula, M. C. (2019). Examining the effects of different teaching strategies on metacognition and academic performance. *Advances in physiology education*, 43(3), 414-422.
- Mekala, S., and Radhakrishnan, G. (2019). Promoting Self-Regulated Learning Through Metacognitive Strategies. *IUP Journal of Soft Skills*, 13(2), 21-30.
- National Universities Commission (NUC) (2021). National Universities Commission (NUC) (2021). Full list of Universities in Nigeria. Retrieved on September 14, 2021, from: online.com.
- Özçakmak, H., Köroglu, M., Korkmaz, C., and Bolat, Y. (2021). The Effect of Metacognitive Awareness on Academic Success. *African educational research Journal*, 9(2), 434-448.
- Padmanabha, C. H. (2020). Metacognition: conceptual framework. *Journal on Educational Psychology*, 14(1), 1-11.
- Radmehr, F., and Drake, M. (2020). Exploring students' metacognitive knowledge: The case of integral calculus. *Education sciences*, 10(3), 55.
- Salendab, F. A., and Laguda, J. L. (2023). Learning purposive communication: A personal narrative experience of non-teacher education students. *International Journal of Multidisciplinary: Applied Business and Education Research*, 4(5), 1682-1696.
- Samaresh, A. (2017). Effectiveness of constructivist approach on academic achievement in science at secondary level. *Academic Journal of Educational Research and Reviews*. 12(22), 1074-1079.
- Tachie, S. A. (2019). Meta-cognitive skills and strategies application: How this helps learners in mathematics problem-solving. *Eurasia Journal of Mathematics, Science and Technology Education*, 15(5), em1702.
- Tobias, S. and Everson, H. (2009). The importance of Knowing What you Know: A Knowledge Monitoring Framework for Studying Metacognition in Education. In D. J.Hacker, J. Dunlosky, and A. C. Graesser (Eds.), *Handbook of Metacognition in Education*. New York, NY: Routledge.
- Yildirim, R. and Ortak, Ş. (2021). The effects of authentic learning approach on academic achievement and attitudes in social studies course. *International Journal of Psychology and Educational Studies*, 8(3), 193-208.