

EFFECTS OF METACOGNITIVE INSTRUCTIONAL STRATEGY ON ACADEMIC ACHIEVEMENT AND RETENTION IN ARCHITECTURAL DRAWING AMONG TECHNOLOGY EDUCATION STUDENTS IN NIGERIA UNIVERSITIES

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A paper presented at international conference organized by School of Science and Technology Education held at Federal University of Technology, Minna, Niger on 7th-11th October, 2024.

ABSTRACT

Modern instructional strategy allows students to actively engage in learning, exploring new ideas, and grasping the concept of learning in a deeper and more meaningful way. This can be achieved if students are aware on how to regulate and monitor their cognitive strategy that leads to higher order thinking for their learning process. The study examined the effects of metacognitive instructional strategy on academic achievement and retention in architectural drawing among technology education students in universities in Northern States, Nigeria. The study adopted a Pre-test, Post-test, post-post-test quasi-experimental design. The study used 245 (218 males and 27 females) final year students of building technology education. The experimental group consisted of 65 (45 males and 10 females) students, while the control group consisted of 180 (163 males and 17 females) students. The researcher developed and validated three instruments: Architectural Drawing Pre-Test (ADPT), Architectural Drawing Achievement Test (ADAT), a four-item theory questions with reliability coefficient of 0.89 and Metacognitive Teaching Strategy (MTS). The experiment period lasted for 6 weeks for both control group and experimental group respectively. three research questions were answered and their corresponding three research hypotheses were tested. The research questions were answered using descriptive statistics of mean and standard deviation. Hypotheses testing one and three were tested using an independent sample t-test while hypothesis two, was tested using Analysis of Covariance (ANCOVA) at $p \leq 0.05$, level of significance. There is existence of a significant difference between the entry performance mean scores of the experimental and control groups in favour of the experimental group. There was a significant difference between the post-test mean scores and retention ability of the experimental and control groups in favour of the experimental group respectively. Hence, the strategy was effective in enhancing students' academic performance and ability to retain the information learned. It is recommended that lecturers should use metacognitive instructional strategy in teaching drawings. Technology/technical educators should appreciate metacognitive activity and develop ways to foster it within all students.

Keywords: Metacognitive Instructional Strategy, Architectural Drawing, Academic Achievement and Retention

INTRODUCTION

Choosing an instructional strategy in technology education is to impart knowledge that brings fundamental change in the learners. To facilitate the process of knowledge transmission, teachers need appropriate instructional strategies to improve students' learning processes that suit specific objectives. 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 (2009) hierarchical model of metacognition for metacognitive instructional strategy involves: planning, selecting strategies, evaluating learning and knowledge monitoring which can be control for learning processes. Learner with good metacognitive skills and awareness uses these components of metacognitive strategy to oversee his/her own learning process by planning, monitoring ongoing cognitive activities, and compare cognitive outcomes with internal or external standards (evaluation). Strategy instruction in metacognition enhances learners' independent learning and autonomous learning and help learners to take responsibility for their own learning (Zimmerman, 1995; Schraw, 1998; Andrade, 1999; Todd, 2002; Aliyu, 2016).

The components in metacognitive instructional strategy are interlocked with student's goals or objectives in the learning process (Tobias and Everson, 2009). It is important to distinguish between cognitive strategy, such as solving problem, and metacognitive strategy, such as evaluating whether the new knowledge has been obtained during instruction. Cognitive strategies are those strategies that are directly related to information processing and can be used to acquire, store and use information better. In contrast, metacognitive strategy is a method used by individuals to plan, monitor and regulate learning (Weinstein, Acee, Jung; Winne, 2011). In an attempt to make such a distinction clear, cognitive strategy 'facilitate' learning and task completion, whereas 'metacognitive' strategy 'monitor' the process of cognitive strategies during instruction. Students consciously or unconsciously engage in the stages of metacognitive strategy during instruction, strategy about learning rather than learning strategies themselves (Al-Khatib, 2010). Teachers use metacognitive strategy components as sequential processes to control students' cognitive activities to achieve cognitive goal, for example, understanding a text or problem situation has been met that is being aware of what to learn (Winne, 2011; Moghtaderi, and Khanjani, 2013; Cevat, 2014).

The strategy allows students to construct their own understanding (new knowledge) of the content as related to prior knowledge and develop a personal feeling about the learnt concepts. The student-learning strategy puts more emphasis on a student as a center point of learning where students can plan, monitor and regulate their learning processes known as metacognitive strategy (Kasimi, 2012; Stephen and Joshua, 2017). If this strategy is actively used in a strategic manner, can improve students' academic achievement and also, enhance students' memory to retain the previous knowledge as it relates to new knowledge in science, technology, engineering and mathematics subjects (Cook, Kennedy and McGuire 2013; Aliyu 2016). It is therefore essential for building technology education students to also develop their ability to gain knowledge of metacognitive strategy, and extend the application of this strategy to control their architectural drawing among other related technology courses.

Architectural drawing is one of the building technology education courses offers in both Federal and State-owned universities. Architectural drawing is synonymous as building drawing in some universities offering building technology education and other tertiary institutions that deal with drawing and its interpretation (National Universities Commission (NUC). Architectural drawing comprises of presentation of drawing (isometric, oblique and perspective), projection (plan, block plan, site plan, front elevation, rear-side elevation, left-side elevation and right-side elevation), section, architectural drawing and model with the use of drawing instruments: tools and equipment (Samuel, 2018). It requires motor 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 one.

Students offering drawing are expected to create a visual representation that identifies and shows the interconnections among various jointed line during teaching-learning process of constructing and interpreting architectural drawing. Hence, teachers of building technology education need to apply metacognitive instructional strategy to suit specific objectives of architectural drawing for academic achievement (Elvis, 2013; Ganyaupfu, 2013). To facilitate the process of knowledge transmission in architectural drawing, architectural drawing students need effective and active learning strategy to connect, construct and interpret the drawing rather than strategy that are passive in nature. It is of a necessity that a skillful teacher needs to be conversant with various instructional strategies which may be applied to subjects at different class situations.

With regard to architectural drawing, learners are expected to take active responsibility for their own learning and use a good learning strategy, which enable them to plan, monitor, manage and reflect on the process of learning. Metacognitive strategy is closely linked to the development of self-regulated learning. Hence, students who use self-regulated strategies are intrinsically self-motivated and prove to be autonomous learners (Rozilawati and Ganakumaran, 2013). These types of learners are metacognitively, motivationally and behaviorally active participants in their own learning process (Lucija, 2017). Such learners according to Aliyu (2016) successfully make use of cognitive and meta-cognitive strategies and they are always engaged in self-regulated learning to knowing what to do, how to do and when to do in order to achieve academic success.

Academic achievement reflects the outcome of teaching-learning process in terms of marks, grades and means scores and the skills possesses during instruction (Alburaidi and Ambusaidi, 2019). The extent to which a student, teacher or institution has achieved their short-term or long-term educational goal can be referred to academic achievement (Cevat, 2014; Gladys (2017). According to Owodunni (2014) metacognitive strategies play an important role in problem solving, attention, memory, social cognition, personality development, communication among others which are concerns for school academic achievement. Architectural drawing is a technical oriented course that involves psychomotor skills to connect, construct and interpret drawing techniques that needs metacognitive strategy to improve architectural drawing concepts. Skills in metacognitive strategy creates awareness that challenge students to 'learn how to learn' in order to achieve academic success (Asy'ari, Ikhsan and Muhali, 2019). According to Ganyaupfu (2013); Gladys (2017); Ozdemir and Sahal (2018) instructional strategies such as demonstration method does not really foster critical thinking, creative thinking and not flexible enough to lead to academic achievement unlike metacognitive instructional strategy.

Metacognitive instructional 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 into a long-term memory is what technology education students need to activate in academics for successful achievement. If information is to be retained and retrieved for use over an extended amount of time, it must be stored in long-term memory as schemata (Adeniji, Ameen, Dambatta and Orilonise (2018). Hence, memory is essential for individuals to remember experiences and use them to respond to future events (retention).

Retention is the continued possession, use, or control of knowledge acquired. According to Gambari, Falode and Adegbenro (2014) learning retention is a direct correlate of positive transfer of learning. Students' learning retention is a process of ensuring student success. This means that high retention may lead to high academic achievement, which is a factor of many variables such as interval between learning and retrieval, teaching strategies, environment among others. Thus, understanding retention and what facilitates it can help teachers select strategy like that of metacognitive instructional strategy to improve the retrieval of information among students. Building technology students' learning retention can be retained and sustained for either a short or a long period of time if a memorable learning strategy like that of Metacognitive strategy components are employed. (Aliyu, 2016). Hence, this study tends to investigate the effects of metacognitive instructional strategy on achievement and retention in architectural drawing among technology education students in Nigeria universities.

Statement of the Problem

The challenge of effectively teaching subject concepts has often been linked to the instructional methods employed by teachers, among other factors. Samaresh (2017) and Yildirim and Ortak (2021) suggested that traditional teaching strategies may fail to engage students, leading to a lack of interest in the subject matter. Similarly, Obioma (2011), Aliyu (2016), and 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.

In Nigerian universities, architectural drawing and other related drawing courses are often taught using traditional methods that may not effectively stimulate students' engagement or motivation. The instruction employed most times tend to focus on guiding students to the end result such as completing a drawing without employing instructional strategies that enhance students' understanding and manipulation of the skills necessary for architectural drawing. As a result, students of building technology education may approach architectural drawing by merely applying memorized steps or procedures, without fully grasping the underlying concepts or developing the necessary skills.

Active instructional strategies, which bridge abstract and concrete knowledge, are essential for making the learning process memorable both during and after class. Beyond the issue of ineffective

instructional strategies, the problem of student learning retention is also significant. The ability of students to retain, sustain, and recall knowledge when needed is closely tied to the teaching and learning strategies employed (Aliyu, 2016; Ozdemir and Sahal, 2018). Furthermore, empirical studies indicated that metacognitive instructional strategies can significantly enhance students' learning retention while improving academic achievement (Dunlosky and Metcalfe, 2009; Aliyu, 2016). This underscores the need for teachers in technology education to invest in the development and implementation of instructional methods that foster higher-order thinking in architectural drawing and related technical courses.

The discrepancies in students' awareness of their own learning abilities appear to be a critical gap in the teaching-learning of architectural drawing at the university level. This gap emphasizes the need for alternative instructional methods that can better enhance students' understanding and retention of architectural drawing 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 (particularly drawing courses) at the university level. In response to this gap, the present study determines the effects of metacognitive instructional strategy on academic achievement and retention in architectural drawing among building technology education students in Nigeria universities.

Objectives of the Study

The objectives of the study are to determine the effects of metacognitive instructional strategy on academic achievement and retention in architectural drawing among technology education students in Nigeria universities. Specifically, the study sought to:

1. establish the building technology education students' entry behaviour prior to the experiment.
2. determine the effect of metacognitive instructional strategy on students' academic achievement in architectural drawing.
3. determine the effect of metacognitive instructional strategy on students' learning retention in architectural drawing.

Research Questions

The following research questions guide the study.

1. What is the building technology education students' entry behaviour prior to the experiment?

2. What is the effect of metacognitive instructional strategy on students' academic achievement in architectural drawing as against those taught with traditional method?
3. What is the effect of metacognitive instructional strategy on students' learning retention in building drawing compared to demonstration method?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 significance levels:

- H₀₁: There is no significant difference between students' entry behaviours prior to the experiment in both federal universities and state-owned universities.
- H₀₂: There is no significant effect in the academic achievement of building technology education students taught architectural drawing using metacognitive instructional strategy and those taught using traditional method.
- H₀₃: There is no significant effect in the learning retention of building technology education students taught architectural drawing using metacognitive instructional strategy and those taught using traditional method.

METHODOLOGY

The study adopted quasi-experimental design in which pre-test, post-test, postpost-test nonequivalent, non-randomized control group design involved. The study covers northern states of Nigeria. Northern region comprises of three zones which are: north-central zone, north-east zone and north-west zone that made of nineteen (19) states. North-central zone consists of six states (Benue, Kogi, Kwara, Nassarawa, Niger and Plateau states) and north-east zone has six states (Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe) while north-west zone comprises of seven states (Jigawa, Kaduna, Kano, Kastina, Kebbi, Sokoto and Zamfara).

Population of the Study

The study's population consists of all final-year building technology education students in universities across the northern states of Nigeria. According to statistics from the National Universities Commission (NUC, 2021), there are nine universities offering building technology education in these regions (seven federal universities and two state-owned).

Sample and Sampling Techniques

The study employed a multi-stage sampling technique. In the first stage, purposive non-probability sampling was used to select all the universities offering technology education (building technology education in particular) as suggested by Teddlie and Yu (2007). The universities offering

technology education from the northern region of Nigeria are: Federal University of Technology, Minna; Abubakar Tafawa Balewa University, Bauchi; University of Jos; Benue State University, Makurdi; Kano University of Science and Technology, Wudil. Bayero University, Kano; Federal University, Wukari, Tabara State; Modibbo Adama University of Technology, Yola; and University of Ilori. These universities were sampled based on their structural characteristics, homogeneity in staffing, funding, facilities, and similarities in teaching and learning environments, such as the time allocated to teaching, teaching methods, staff qualifications and experience, and overall achievement in architectural/building drawing.

In the second stage, a random sample of four universities was selected using a table of random numbers. In the third stage, two universities: Federal University of Technology, Minna (34 students) and Modibbo Adama University of Technology, Yola (31 students) were randomly assigned to experimental group using a coin flip, as suggested by Bryman (2008). The remaining two state-owned universities: Kano University of Science and Technology, Wudil (154 students) and Benue State University, Makurdi (26 students) were directly assigned to the control group. In total, 245 students were sampled for the study.

Instrument for Data Collection

The instruments used for data collection are as follow: Architectural Drawing Pre-Test (ADPT), Architectural Drawing Achievement Test (ADAT), and Metacognitive Teaching Strategy (MTS) respectively.

i. Architectural Drawing Pre -Test (ADPT)

At the beginning of the study, the Architectural Drawing Pre-Test (ADPT) was administered to assess the students' prior knowledge in architectural drawing. The pre-test comprised four theory-based questions (building floor plans, elevations, cross-sections, and roof plans).

ii. Architectural Drawing Achievement Test (ADAT) (Post-Test)

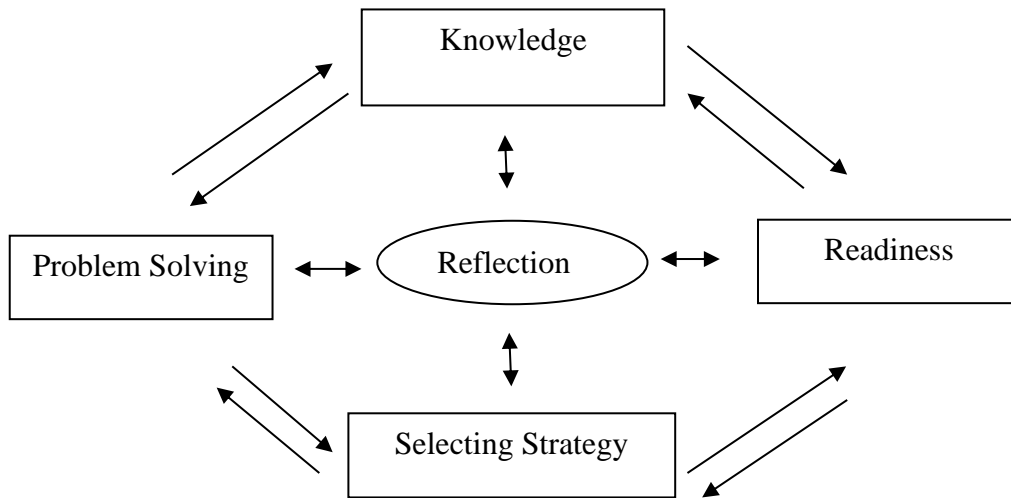
Architectural Drawing Achievement Test (ADAT) was employed to measure students' achievement in architectural drawing. The test comprised of four theory questions (building floor plan, elevations, cross - section and roof plan).

iii. Metacognitive Teaching Strategy (MTS)

The metacognitive teaching strategy was developed based on Tobias & Everson's (2009) hierarchical model of metacognition. Their model, according to Erskine (2009), distinct from other theoretical models due to its emphasis on the incremental development of metacognitive skills,

making it more appropriate for teaching purposes. Metacognitive Teaching Strategy is a five-stage non-linear, clockwise and anti-clockwise. The strategy started with knowledge monitoring, readiness, selecting strategy, problem solving and has reflection in the center.

Figure 2: Metacognitive Strategy Teaching Model (MSTM)



Source: Tobias & Everson (2009)

Reliability of the Instrument

The drafted instrument was subjected to face and content validation by three experts, two from the Department of Industrial and Technology Education (Building Option), Federal University of Technology, Minna and Department of Vocational and Technology Education (Building Option), Faculty of Technology Education, Abubakar Tafawa Balewa University, Bauchi. A pilot testing of the instruments was conducted in Ekiti State University with 15 undergraduate final year students, comprising of 13 males and 2 females. Cronbach alpha formula was used to determine the internal consistency of the instrument. The reliability coefficient of the instrument was determined to be 0.89 with the aid of a research assistant (lecturer from the same university).

Method for Data Collection

Before the commencement of the experiment, students were assessed to ascertain their prior knowledge by administering a pre-test (ADPT) along with the help of research assistants. Treatment/non-treatment sessions for the experimental/control groups were conducted by the research assistants with the aid of lesson plans prepared by the researcher respectively after which a post-test (ADAT) was conducted. Two weeks after, the post-test (ADAT) was re-administered to assess students’ retention ability.

Method of Data Analysis

Five research questions were answered using descriptive statistics in the form of mean and standard deviation. Hypotheses 1 and 3 were tested using an independent sample t-test, while hypothesis 2, was tested using Analysis of Covariance (ANCOVA) at .05 level of significance. Decisions on the hypotheses were based on comparing the significant values (level of significant) with ($P \leq 0.05$). If the significance value is equal or greater than ($P \leq 0.05$), the hypothesis is upheld or otherwise rejected.

RESULTS

Research question one: What is the building technology education students' entry performance prior to the experiment? Answer to this research question is presented in table 1.

Table 1: Descriptive statistic of building technology education students' entry performance prior to the experiment.

Variable	Group	N	Mean	Std. D	Mean Diff.
Pre-test	Metacognitive	65	14.35	2.786	1.065
	Traditional	180	13.29	1.919	
	Total	245			

Note: N= Number of Respondents Std. D= Standard Deviation, Mean Diff= Mean Difference

The result in table 1, indicates that there was existence of difference in the performance of building technology education students assigned to metacognitive instructional strategy ($M = 14.35$, Std. D = 2.786) and those assigned to demonstration method ($M = 13.29$, Std. D = 1.1919) prior to the experiment in favour of metacognitive instructional strategy group. This indicates that, students who were assigned to the metacognitive instructional strategy group performed better than those assigned to the demonstration method group even before the experiment started. However, the analysis of covariance would take care of this difference because it removes the initial difference between the groups and performs the normal variance analysis on the adjusted scores.

Research question two: What is the effect of metacognitive instructional strategy on students' performance in building drawing compared to traditional method? Answer to this research question is presented in table 2.

Table 2: Descriptive statistic of the effect of metacognitive instructional strategy on students' performance in building drawing compared to demonstration method.

Variable	Group	N	Mean	Std. D	Mean Diff.
Pre-test	Metacognitive	65	66.48	5.500	7.12
	Traditional	180	59.36	5.907	
	Total	245			

Note: N= Number of Respondents Std. D= Standard Deviation, Mean Diff= Mean Difference

The result in table 2, revealed that there was a difference in the performance of building technology education students taught using metacognitive instructional strategy (M=66.48, Std. D =5.500) and those taught using demonstration method (M=59.36, Std. D =5.907) in favour of metacognitive instructional strategy group. This indicates that the metacognitive instructional strategy was more effective in improving students' performance in building drawing compared to the traditional method.

Research question three: What is the effect of metacognitive instructional strategy on students' learning retention in building drawing compared to demonstration method? Answer to this research question is presented in table 3.

Table 3: Descriptive statistic of the effect of metacognitive instructional strategy on students' learning retention in building drawing compared to demonstration method.

Variable	Group	N	Mean	Std. D	Mean Diff.
Retention	Metacognitive	65	73.75	7.634	4.26
	Traditional	180	59.49	7.605	
	Total	245			

Note: N= Number of Respondents Std. D= Standard Deviation, Mean Diff= Mean Difference

The result in table 3, revealed that there was a difference in the retention scores of building technology education taught building drawing using metacognitive instructional strategy (M=3.96, Std. D =.511) and those taught using demonstration method (M=3.80, Std. D =.426). This indicates that, building technology education taught building drawing using metacognitive instructional strategy have better retention ability than their counterparts in taught using demonstration method.

Test of hypothesis 1: There is no significant difference between the entry performance of building technology education students assigned to metacognitive instructional strategy and those assigned to demonstration method prior to the experiment. The answer to this hypothesis is presented in table 4.

Table 4: Independent samples t-test for entry performance of building technology education students assigned to metacognitive instructional strategy and those assigned to demonstration method prior to the experiment

Levene's Test for Equality of Variances								
Variable	Groups	N	F	Sig.	t-value	Mean	SD	Sig. (2-tailed)
Pre-test	Metacognitive	65	26.309	.000	2.847	14.35	2.786	.006
	Demonstration	180				13.29	1.919	

The outcome of independent-samples t-test in table 4 indicated that there is existence of a significant difference between the entry performance of building technology education students assigned to metacognitive instructional strategy ($M = 14.35$, $Std. D = 2.786$), and those assigned to demonstration method prior to the experiment ($M = 13.29$, $Std. D = 1.1919$), $t(243) = 2.847$, $p = .006$. Null hypothesis one was therefore, Rejected. This finding indicates that students in the metacognitive group started with a stronger initial understanding but ANCOVA appropriated the initial difference between the groups.

Test of hypothesis 2: There is no significant difference in the performance of building technology education students taught building drawing using metacognitive instructional strategy and those taught using demonstration methods. The answer to this hypothesis is presented in table 5.

Table 5: ANCOVA Result of difference in the performance of building technology education students taught building drawing using metacognitive instructional strategy and those taught using demonstration methods

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4583.144 ^a	2	2291.572	92.117	.000
Intercept	11362.669	1	11362.669	456.759	.000
Pretest	2161.298	1	2161.298	86.880	.000
Group	1464.021	1	1464.021	58.851	.000
Error	6020.162	242	24.877		
Total	929583.000	245			
Corrected Total	10603.306	244			

An ANCOVA was performed to compare the difference in the performance of building technology education students taught building drawing using metacognitive instructional strategy and those taught using demonstration methods. The result of ANCOVA presented in Table 5 shows that after controlling or adjusting for the initial difference in the building drawing performance of the students in the two groups, there was a significant difference in the performance of building technology education students taught building drawing using metacognitive instructional strategy and those taught using demonstration methods in favour of metacognitive instructional strategy $F(1, 242) = 58.851$, $p = .000$. This finding indicates that after controlling the initial differences in students' building drawing performance, the metacognitive instructional strategy proved to be more effective in enhancing the students' performance in building drawing compared to the demonstration method.

Test of hypothesis 3

There is no significant difference in the retention of building technology education students taught building drawing using metacognitive instructional strategy and that those taught using demonstration methods. The answer to this hypothesis is presented in table 6.

Table 6: Independent samples t-test for difference in the retention of building technology education students taught building drawing using metacognitive instructional strategy and that those taught using demonstration methods.

Levene's Test for Equality of Variances								
Variable	Groups	N	F	Sig.	t-value	Mean	SD	Sig. (2-tailed)
Retention	Metacognitive	65	1.076	.301	12.944	3.96	.511	.000
	Demonstration	180				3.80	.426	

The statistical evidence presented the independent-samples t-test in table 6 indicates that there was a statistically significant difference in the mean retention of building technology education students taught building drawing using metacognitive instructional strategy ($M=73.75$, $Std. D=7.634$) and those taught using demonstration method ($M=59.49$, $Std. D=7.605$). $t(243) = 12.944$, $p = .000$. Null hypothesis four was, therefore, rejected. This finding suggests that the metacognitive instructional strategy is more effective not only in improving immediate performance and attitudes but also in helping students retain what they've learned over time.

Summary of the Major Findings

From the result of the analysis, the following major findings emerged from the study.

1. The students who were assigned to the experimental group performed better than those assigned to the control group prior to the experiment. The hypothesis affirmed that experimental group started with a stronger initial understanding of the drawing.
2. The students that received experimental group performed significantly better than the control group. This indicates that metacognitive instructional strategy was more effective in improving students' performance than control group.
3. The students taught building drawing under experimental group have better retention ability than their counterparts in the control group. The hypothesis revealed that metacognitive instructional strategy is more effective in helping students retain what they've learned over time.

Discussion of the Findings

The findings of research question one which is supported by test of its corresponding null hypothesis revealed that the students who were assigned to the experimental group performed better than those assigned to the control group prior to the experiment. The finding of this study agreed with that of Goldberg and Bush (2009) who examined the impact of teaching metacognitive strategies on third-grade students' metacognitive and problem-solving skills. The study established the prior knowledge among the experimental and control groups of the study. They affirmed that, there was existence of difference in the performance of students assigned to experimental group and those assigned to control group. In a related studies, the findings of Erkan (2019) investigated the effect of the metacognitive strategy on the writing skills of pupils in secondary education; Jody, Diana, Megan, Jessica, Matthew and Manuela (2019) examined the effects of different teaching strategies on metacognition and academic performance; Eze, Obidile and Akamobi (2019) worked on relative effectiveness of constructivism and meta-learning teaching methods on academic achievement and retention of basic electricity were all in agreement with the present study that there is significant difference in their pre-tests mean scores prior to the experiment due to the prior knowledge as regard to the build-up courses.

The findings of research question two and the test of its null hypothesis indicated that metacognitive instructional strategy was more effective in improving students' performance in building drawing compared to the traditional method. The findings of this study concurred with existing literature, such as the studies conducted by Bawa (2011); Javanmard, Hoshmandja and Ahmadzade (2012) and Moga (2012) 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 traditional method. Similarly, Sirmacı and Tuncer (2013), Smith (2013), Eze, Obidile Akamobi (2019) and Jody, Diana, Megan, Amy, Jessica, Matthew and Manuela (2019) also in agreement in their various studies that metacognitive teaching strategy performed better than traditional method. Sirmacı and Tuncer (2013) investigated the effects of metacognition strategies applied in 7th grade mathematics course (Permutation and Probability) on students' achievement, metacognition skills, attitudes and permanence. The result indicated that teaching with metacognition strategies is more effective than the traditional teaching to increase the achievement of students in mathematics course and the result showed that metacognition strategies is significantly effective than traditional

method. Also, the study of Jody, Diana, Megan, Amy, Jessica, Matthew and Manuela (2019) examined the effects of different teaching strategies on metacognition and academic performance. The result shown that there is significant effect of different metacognitive interventions than that of lecture method.

The researchers compared the results of their studies between metacognitive teaching strategy and lecture (traditional) method, there is no single research study that has relatively compared metacognitive teaching strategy with demonstration method. Meanwhile, Architectural drawing is a psychomotor skill course that can be taught by linking and joining lines together from one point to another through a demonstration way of teaching. This is likely so, because students have constant themselves with the demonstration method as regards to drawing courses.

The findings of research question three and the test of its corresponding null hypothesis revealed that, there was a statistically significant effect in the learning retention of students taught architectural drawing using metacognitive teaching strategy and those taught using traditional method. The finding in this study is in agreement with the findings of Eze, Obidile and Akamobi (2019), 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. The study showed that meta-learning teaching method had a significant effect on students' retention ability against lecture method. Likewise, Bergstresser (2013) 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.

The findings of this study agreed with the findings of Aliyu (2016) that investigated the impact of metacognitive strategy on attitude, retention and performance in calculus among colleges of education students. This study shown that metacognitive instructional strategy significantly improves students' achievement and retention abilities. In addition, the finding is also agreed with that of Yildirim and Ortak (2021), who studied the effects of the authentic learning approach in social studies on academic achievement, retention of knowledge, and attitude towards the course.

Analyses of the result revealed that the students in the authentic learning approach exhibited better retention abilities.

Summary

The chapter highlights the summary of the research study, the conclusion and made some recommendations based on the findings discovered in the study. This study investigated the effect of metacognitive instructional strategy on achievement, retention, attitude and gender in architectural drawing among building technology education students in universities. The study is guided by five (5) specific objectives, five (5) research questions and five (5) null hypotheses. Relevant literature both conceptual and empirical are reviewed based on the focus of the study. The Population of the study comprises of 245 building technology education final year students offering architectural drawing (65 students for experimental group and 180 students for control group). The researcher manipulated the independent variable (metacognitive teaching strategy) and observed the effect on the dependent variables (performance, retention, attitude and gender). Four instruments were adopted for data collection are as follow: Architectural Drawing Pre -Test (ADPT), Architectural Drawing Achievement Test (ADAT), Metacognitive Teaching Strategy (MTS), and Attitude Towards Architectural Drawing Inventory (ATADI) respectively. The tests consist of four theory questions developed by the researcher covering the contents of building floor plan, elevations, cross-section and roof plan.

The study adopted quasi-experimental design in which pre-test, post-test and postpost-test non-equivalent, non-randomized control group design. Data collected were analyzed using descriptive statistics of mean, standard deviation, analysis of covariance (ANCOVA) which is known as univariate analysis of variance and multivariate analysis of variance (MANOVA) were used to answer research questions and test the null hypotheses at 0.05 levels of significance for accepting or rejecting the hypothesis. Hypotheses 1, 3 and 4 were tested using an independent sample t-test, hypothesis 2, was tested using ANCOVA while hypothesis 5, was tested using MANOVA. The findings of the study revealed that metacognitive instructional strategy has significant effects on student's academic achievement, learning retention ability, positive attitude without gender bias. To the best of the researcher's knowledge, no published study was found to examine the effectiveness of metacognitive instructional strategy on achievement, retention, attitude and gender in architectural drawing among building technology education students in northern state universities, Nigeria.

Conclusion

Introducing a new method or alternative means of teaching-learning drawings in the new area of technology education as a means of innovation and novelty cannot be over emphasized for academic achievement. A main contribution of the present study was to examine the effectiveness of metacognitive instructional strategy on achievement and retention in architectural drawing among building technology education students in northern universities. It is important to know that metacognitive instructional strategy puts emphasis on how students can plan, monitor and regulate their learning processes in order to achieve academic goal. Based on the findings from the study, the following conclusions were drawn:

1. that due to the fact that student's exposure to metacognitive instructional strategy scored higher in the architectural drawing achievement tests, a conclusion can be made that the building technology education students' performance can be enhanced by receiving explicit instruction in metacognitive strategy.
2. having metacognitive instructional knowledge for selecting and using relevant strategies means that, building technology education students are not only able to think but are also able to consciously decide about the process of learning. Therefore, the explicit instruction of metacognitive strategy seems to have contributed to the students' ability in learning of the architectural drawing concepts.
3. this study shows that teaching using metacognitive instructional strategy is effective in enhancing building technology education students' retention ability.

Recommendations

In view of the results of these findings, the following recommendations are hereby presented:

1. Since instructions in metacognitive strategy enhances students' independent and autonomous learning that allows learner to take responsibility for their own learning. However, Students of building technology education should always use the components of metacognitive instructional strategy to oversee his/her own learning process by planning, monitoring ongoing cognitive activities (learning), and compare cognitive outcomes with internal or external standards (evaluation).
2. Teachers of technology education and other trades related technical education involving drawings should be given on-the-job training opportunities such as short-term courses, seminars and workshop to enable the teachers to update their knowledge with the ever-

changing scientific knowledge and various modern methods of teaching technology courses and trade subjects. Specifically, such seminars or workshop can be arranged for the lecturers of technology education as regards to the strength of metacognitive instructional strategy that can serve as alternative method of teaching-learning architectural drawing.

3. Government and other relevant bodies should be implored to give enough grants to equip technology/technical drawing studios. Metacognitive teaching strategy cannot be effectively carried out in ill-equipped drawing studios.

The study has contributed to knowledge in the following ways:

1. This study contributes to the research on metacognitive instructional strategies by providing an applicable teaching model for architectural/technical/building drawing concepts. The teaching model proved to be effective in improving the students' use of metacognitive instructional strategies and provided empirical support for other research findings in that area.
2. The current study provides an initial step towards examining the effect of metacognitive instructional strategy in universities programme in the region. This will enable other researchers to replicate the study in other region, thus further ascertaining the effectiveness of the instructional process.

Implication of the Study

The study has some implications for teaching-learning of architectural drawing. The use of metacognitive instructional strategy is a five-stage non-linear, clockwise and anti-clockwise in teaching-learning architectural drawing in the universities has potential in enhancing and improving students' academic achievement and retention abilities in architectural drawing. This method of teaching allows lecturers to assess the students' entry behavior that is, connecting prior knowledge and the new activities that enables learners to understand the unified and interconnected lines of architectural drawing. This implies that; students will be able to recall the prior knowledge (retention) while solving the tasks at hand and attain academic success in architectural drawing to individual student and still retain or sustain metacognitive knowledge for academic achievement.

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