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EFFECTS OF BRAINSTORMING, JUST-IN-TIME AND DEMONSTRATION TEACHING TECHNIQUES ON STUDENTS' COGNITIVE ACHIEVEMENT AND RETENTION IN DIGITAL ELECTONICS IN COLLEGES OF EDUCATION IN NORTH-WEST NIGERIA

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Abstract
The study identified the effects of brainstorming, Just-in-Time and demonstration teaching techniques on students' cognitive achievement and retention in Digital Electronic in Colleges of Education in North-West Nigeria. Two research questions were raised and answered as well as two hypotheses were formulated and test at 0.05 level of significant. The study adopted pretest–posttest non-equivalent control group design of quasi-experimental study. The study was conducted in North-West, Nigeria. The population of this study comprised of the entire 142 Nigerian Certificate in Education (NCE) III electrical/electronic students in all the Colleges of Education in the study area offering technical education. Due to the manageable size of the population of the study, there was no sampling of subjects. The instruments used for data collection include: Digital Electronics Cognitive Achievement and Retention Tests (DECART). The instrument was subjected to face and content validation by three experts. The reliability co-efficient of the instrument was determined as .78 using Kuder-Richardson 20 (K-R 20). The collection of data for the study was achieved through physical administration of the instrument. The study employed the use of descriptive using mean and inferential statistics using Analysis of Covariance (ANCOVA) to analyze the data. The study found out that, brainstorming teaching technique had positive effect on the cognitive achievement and retention of students in digital electronics. The study

recommended among others that, digital electronics lecturers should adopt the use of brainstorming teaching technique to enhance students' cognitive achievement and retention.

Keywords: *Brainstorming, Just-in-Time, Demonstration Cognitive Achievement and Retention*

Introduction

Digital electronics is a compulsory two credit unit course with code: TEE 328 offered by final year Electrical Electronic Technology Education (EETE) students in colleges of education in Nigeria. The course deals with electronic appliances which function on the principle of logic gate and logic decisions with the use of integrated circuits as their main component. According to Federal Republic of Nigeria (FRN, 2012), the course is aimed at equipping students with the knowledge of basic computer parts, types and other devices, computer hardware configuration and techniques of computer aided designs, number system, logic gates, flip-flop, counters, decoders and encoders and microprocessors. Halliru and Muhyideen (2018) noted that, the aim of digital electronics is far from being achieved due to the persistently manifested low student's performance. The low performance of students in the course could be influenced by instructional techniques used by lecturers such as demonstration method.

Demonstration method refers to the type of teaching method in which the teacher is the principal actor while the learners watch with the intention to act later. Here the teacher does whatever the learners are expected to do at the end of the lesson by showing them how to do it and explaining the step-by-step process to them (Ameh *et al.*, 2017). Mundi (2016) described demonstration method of teaching as the display or an exhibition usually done by the teacher while the students are watching with keen interest. The gains of using demonstration method in teaching lies in the fact that it bridges the gap between theory and practice, enables learners to become good observers and generate their interest; students see immediate progress as a result of a correct effort and it enables the lecturer to impart manipulative and operational skills. Despite these benefits, Dorgu (2015) advocated that, improving students' performance

especially in digital electronics require students' centre instructional techniques such as brainstorming.

Brainstorming is one of the most important teaching techniques in provoking creativity and solving problems in the field of education. As the name suggests, brainstorming is meant to stimulate or excite the brain into thinking about issues in a new way. Filgona *et al.* (2016) described brainstorming teaching technique as a technique that emphasizes the participation, dialogue and two-way communication between teacher and students. According to Akinboye (2013), brainstorming teaching technique involves asking of carefully framed questions aimed at teaching students to find out facts and learn skills for themselves and do critical thinking. It encourages students to arrest conventional, logical thinking and embrace spontaneity, originality, and imagination. Eble (2016) noted that, students performed and retained knowledge better when taught using brainstorming teaching technique and other active technique such as Just-in Time Teaching technique.

Just-in-Time Teaching (JiTT) technique is problem based and student centred learning approaches that allow students to learn and express their idea about yet to be taught topic. The technique combined the use of out-of-class web-based exercise with active learning pedagogy. According to Simkins and Maier (2016), JiTT technique engage students with reading to answer warm-up questions on new topics outside the class and submit electronically prior to the classroom activity. The teacher review students' response prior to the class and use the responses to organize and modify the upcoming classroom session. Cookman (2010) revealed that, students' responses let the teacher tailor lectures, demonstrations, discussions or other teaching and learning activities to reinforce the students' understanding and correct their misconceptions. According to Pace and Middendorf (2017), the pre-class experience the students acquired in the course of doing the assignment enhances their learning outcomes. Moreover, the conspicuous similarity among JiTT, brainstorming and demonstration techniques is their ability to enhance students' cognitive achievement.

Cognitive achievement refers to students' ability to perform various mental activities most closely associated with learning and problem solving. Olatoye and Aderogba (2011) defined cognitive achievement as a general mental

capability involving reasoning, problem solving, abstract thinking complex idea comprehension and learning from experience. The mental ability of EETE student to display high level knowledge after learning digital electronics as a course over the years is generally low. Oyetunde (2010) disclosed that, cognitive achievement of EETE students in digital electronics is declined due to non-utilization of effective teaching techniques among lecturers such as brainstorming, JiTT and demonstration. According to Afolabi and Akinbobola (2019), the low cognitive achievement among students hinders positive development of the overall learning outcomes. This implies that, the low cognitive achievement of students in digital electronics largely affect students' retention of knowledge.

Retention of knowledge is the ability of an individual to reproduces valuable knowledge after a period of time. According to Adamu (2016), retention of knowledge is the repeat performance by a learner of the behaviour earlier acquired, elicited after an interval of time. Retention in the context of this study refers to the extent to which digital electronics students repeat performance earlier acquired after an interval of time. Green (2017) noted that, retention of knowledge is affected by the learner's memory capacity and the instructional techniques utilized by lecturers. Akinbobola (2019) further stated that, the low retention of knowledge among students is due to non-utilization of active teaching techniques such as brainstorming, JiTT and demonstration. This implied, these active instructional techniques may have the tendencies of enhancing students' retention of knowledge. Hence, this study sought to investigate the effect of brainstorming, JiTT and demonstration teaching techniques on students' cognitive achievement and retention in digital electronics in colleges of education in North-West, Nigeria**.**

Statement of the Research Problem

Digital electronics is aimed at equipping EETE students with the knowledge and skills in the maintenance of digital electronics appliances. To realize this aim, Governments at both State and federal levels have made provision for several inputs that include, building structures, well designed and developed curriculum as well as teaching staff to ensure effective learning. Unfortunately, despite these efforts by the Governments, it seems as if the aim is defeated as

results of the continuous low cognitive and skill achievement, and declining interest of students in studying EETE courses such as digital electronics as revealed by Halliru & Muhyideen (2018). The examination records on the performance of student's in digital electronics in North-West, Nigeria from 2015 to 2019 as shown in Appendix A (p91) revealed that, in 2014/2015 academic session, 51.06% failed, 48.09% in 2015/2016 and 50% in 2016/2017, 50.86% in 2017/2018 and 48.52% in 2018/2019. Supporting this claim, Azih and Nwosu (2018) reported that, the achievement of students in digital electronics is generally low in examinations due to use of non-effective methods of teaching such as demonstration and lecture methods that do not take into account the needs of students, their interests, their tendencies and their desires as well as the absence of educational technology. Okon (2018) equally noted that, demonstration method of teaching that is mostly used by colleges of education lecturers is not challenging enough to meet the needs of the EETE students.

The continued use of lecture and demonstration methods in teaching digital electronics to students largely manifests some shortcomings that reflect low academic achievements among students in school subjects such as digital electronics (James, 2015). In a quest to address these shortcomings, there is an urgent need for teaching technique to keep up with the contemporary times in order to improve students' academic achievement, interest and retention in digital electronics. Thus, the study determined the effect of brainstorming, JiTT and demonstration teaching techniques on students' cognitive achievement and retention to ascertain the most suitable teaching technique in order to enhance students' cognitive achievement and retention in digital electronics in colleges of education in North-West, Nigeria.

Aim and Objectives of the Study

The aim of the study was to determine the effect of brainstorming, JiTT and demonstration teaching techniques on students' cognitive achievement and retention in digital electronics in colleges of education in North-West, Nigeria. Specifically, the objectives of the study are to determine the effect of:

1. Brainstorming, JiTT and demonstration teaching techniques on students' cognitive achievement in digital electronics.

2. Brainstorming, JiTT and demonstration teaching techniques on students' retention of learning in digital electronics.

Research Questions

The following research question were raised and answered:

1. What is the effect of Brainstorming, JiTT and demonstration teaching techniques on students' cognitive achievement in digital electronics?
2. What is the effect of Brainstorming, JiTT and demonstration teaching techniques on students' retention of learning in digital electronics?

Hypotheses

The following null hypotheses were formulated and tested at .05 level of significance:

HO_1: There is no significance difference between the cognitive achievement scores of students taught digital electronics using Brainstorming, JiTT and demonstration teaching techniques**.**

HO_2: There is no significance difference between the retention of learning scores of students taught digital electronics using Brainstorming, JiTT and demonstration teaching techniques.

Methodology

The study adopted pretest–posttest non-equivalent control group design of quasi-experimental study. The design is most suitable for the study since pre-selection and randomization of groups is often difficult in a school setting, intact classes will be used to avoid disruption of normal classes. The study was conducted in North-West, Nigeria. The North-West, Nigeria comprises of Kaduna, Kano, Katsina, Sokoto and Zamfara States. The population of this study comprised of the entire 142 Nigerian Certificate in Education (NCE) III electrical/electronic students in all the Colleges of Education in the study area offering technical education. The sample of the study was the whole population. Due to the manageable size of the population of the study, there was no sampling of subjects. Moreover, purposive sampling technique was used to assigned Federal College of Education (Technical), Gusau and Federal College of Education, Bichi to the experimental group II. This is simply because; the

two colleges of education possessed the necessary learning facilities that support the use of JiTT. Furthermore, Simple Random Sampling Technique was used to assign Isah Kaita College of Education, Katsina and Shehu Shagari College of Education, Sokoto to control group and Kaduna State College of Education, Gidan Waya to experimental group I. The instrument used to collect data for this study was Digital Electronics Cognitive Achievement and Retention Tests (DECART). The DECART was subjected to face and content validation by three experts. The reliability co-efficient of DECART was determined as .78 using Kuder-Richardson 20 (K-R 20). Nevertheless, item analysis was carried out on the 60 items developed in the DECART to ensure that, each item in the test is standardized. The collection of data for the study was achieved through physical administration of the DECART to all NCE III digital electronics students to determine their cognitive achievements and retention in digital electronics. The study employed the use of descriptive and inferential statistics to analyze the data. Descriptive statistics using mean was used to answer all the research questions and inferential statistics using Analysis of Covariance (ANCOVA) to test all the hypotheses at significant level of 0.05.

Experimental Procedures

The study was conducted in 12 weeks' period during which, 8 topics in digital electronics will be covered. The study involved four stages which include: administration of pre-test, treatment, posttest and retention test. The pre-test was administered to all the students involved in the study in the first week of the research exercise before both groups are subjected to treatment. After the administration of the pre-test, the students in the experimental group I and II were taught using brainstorming and Just-in Time Teaching techniques and the students in the control group were taught using demonstration method.

Results:

Research Question 1

What is the effect of Brainstorming, Just-in-time and demonstration teaching techniques on students' cognitive achievement in digital electronics?

Table 1: Mean of Pre-test and Post-test Cognitive Achievement Scores of Students taught Digital Electronics using Brainstorming, Just-in-time and Demonstration Teaching Techniques

Groups		Pretest		Posttest		
	N	Mean	SD	Mean	SD	Mean Gain
Control Group (Demonstration Method)	62	25.14	0.35	67.10	0.30	41.96
Experimental Group I (Brainstorming Technique)	42	26.10	0.30	79.76	0.43	53.66
Experimental Group II (Just-in-time Technique)	38	26.08	0.49	67.08	0.27	41.00

Table 1 shows that, the control group taught with demonstration method had pre-test mean cognitive achievement score of 25.14 with standard deviation of 0.35 and post-test score of 67.10 with standard deviation of 0.30 The mean gained between the pre-test and post-test of the control group was 41.96. The experimental group I taught with Brainstorming technique had pre-test mean cognitive achievement score of 26.10 with standard deviation of 0.30 and post-test score of 79.76 with standard deviation of 0.43. The mean gained between the pre-test and post-test of the experimental group I was 53.66. The experimental group II taught with JiTT had pre-test mean cognitive achievement score of 26.08 with standard deviation of 0.49 and post-test score of 67.08 with standard deviation of 0.27. The mean gained between the pre-test and post-test of the experimental group II was 41.00. The experimental group I had higher mean gained than experimental group II and control group. This indicated that, students taught digital electronics using brainstorming teaching technique had higher mean cognitive achievement scores than students taught using JiTT and demonstration techniques.

Research Question 2

What is the effect of Brainstorming, Just-in-time and demonstration teaching techniques on students' retention of learning in digital electronics?

Table 2: Mean of Pre-test and Post-test Retention Scores of Students taught Digital Electronics using Brainstorming, Just-in-time and Demonstration Teaching Techniques

Groups		Pretest		Posttest		
	N	Mean	SD	Mean	SD	Mean Gain
Control Group (Demonstration Method)	62	25.14	0.35	63.14	0.35	38.00
Experimental Group I (Brainstorming Technique)	42	26.10	0.30	75.27	0.45	49.17

Experimental Group II (Just-in-time Technique)	38	26.08	0.49	63.16	0.37	37.08

Table 2 shows that, the control group taught with demonstration method had pre-test mean retention score of 25.14 with standard deviation of 0.35 and post-test score of 63.14 with standard deviation of 0.35 The mean gained between the pre-test and post-test of the control group was 38.00. The experimental group I taught with Brainstorming technique had pre-test mean retention score of 26.10 with standard deviation of 0.30 and post-test score of 75.27 with standard deviation of 0.45. The mean gained between the pre-test and post-test of the experimental group I was 49.17. The experimental group II taught with JiTT had pre-test mean retention score of 26.08 with standard deviation of 0.49 and post-test score of 63.16 with standard deviation of 0.37. The mean gained between the pre-test and post-test of the experimental group II was 37.08. The experimental group I had higher mean gained than experimental group II and control group. This indicated that, students taught digital electronics using brainstorming teaching technique had higher mean retention scores than students taught using JiTT and demonstration techniques.

Hypothesis One

There is no significance difference between the cognitive achievement scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques

Table 3: Analysis of Covariance for the Test of Significance Difference between the Cognitive Achievement Scores of Students taught Digital Electronics using Brainstorming, Just-in-time and Demonstration Teaching Techniques

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	560.73[a]	3	1869.244	145.6	.000
Intercept	144.38	1	144.380	112.6	.000
Pretest	.02	1	.021	.167	.684

Group	449.78	2	2248.391	174.4	.000*
Error	17.73	138	.128		
Total	754.00	142			
Corrected Total	562.46	141			

a. R Squared = .997 (Adjusted R Squared = .997)

Table 3 shows the F-calculated value for testing the significance difference between the cognitive achievement scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques. The F-calculated value of 174.4 was obtained with associated exact probability value of 0.00. Since the associated probability of 0.00 was less than 0.05 set as level of significance, the null hypothesis which stated that there is no significance difference between the cognitive achievement scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques is rejected. Hence, there is significance difference between the cognitive achievement scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques**.** In order to determine the group responsible for the significance difference, post hoc test was carried out as shown in Table 4.

Table 4: Post hoc Test for the Significance Difference between the Cognitive Achievement Scores of Students taught Digital Electronics using Brainstorming, Just-in-time and Demonstration Teaching Techniques

(I) GROUP	**(J) GROUP**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
CON	EXP I	-12.66*	.071	.000*	-12.83	-12.48
	EXP II	.016	.080	.979	-.18	.21
EXP I	CON	12.66*	.071	.000	12.48	12.83
	EXP II	12.67*	.073	.000	12.49	12.86
EXP II	CON	-.016	.080	.979	-.21	.18
	EXP I	-12.67*	.073	.000*	-12.86	-12.49

Key: CON = Control Group, EXP I = Experimental Group I and EXP II = Experimental Group II

Table 4 reveals p = 0.00 for experimental group I when compared with control and experimental group II. This indicated that, experimental group I (students taught digital electronics using brainstorming teaching technique) is responsible for the significant difference between the cognitive achievement scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques.

Hypothesis Two

There is no significance difference between the retention of learning scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques.

Table 5: Analysis of Covariance for the Test of Significance Difference between the Retention Scores of Students taught Digital Electronics using Brainstorming, Just-in-time and Demonstration Teaching Techniques

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	513.98[a]	3	171.66	107.10	.000
Intercept	116.03	1	11.03	72.82	.000
Pretest	.473	1	.473	2.96	.088
Group	408.51	2	204.75	127.74	.000*
Error	22.06	138	.160		
Total	6703.00	142			
Corrected Total	515.04	141			

a. R Squared = .996 (Adjusted R Squared = .996)

Table 5 shows the F-calculated value for testing the significance difference between the retention scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques. The F-calculated value of 127.74 was obtained with associated exact probability value of 0.00. Since the associated probability of 0.00 was less than 0.05 set as level

of significance, the null hypothesis which stated that there is no significance difference between the retention scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques is rejected. Hence, there is significance difference between the retention scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques. In order to determine the group responsible for the significance difference, post hoc test was carried out as shown in Table 6.

Table 6: Post hoc Test for the Significance Difference between the Retention Scores of Students taught Digital Electronics using Brainstorming, Just-in-time and Demonstration Teaching Techniques

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CON	EI	-12.13*	.080	.000*	-12.33	-11.93
	EII	-.00	.090	.986	-.23	.20
EI	CON	12.13*	.080	.000	11.93	12.33
	EII	12.11*	.082	.000	11.91	12.32
EII	CON	.01	.090	.986	-.20	.23
	EI	-12.11*	.082	.000*	-12.32	-11.91

Table 6 reveals p = 0.00 for experimental group I when compared with control and experimental group II. This indicated that, experimental group I (students taught digital electronics using brainstorming teaching technique) is responsible for the significant difference between the retention scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques.

Findings

- Students taught digital electronics using brainstorming teaching technique had higher mean cognitive achievement scores than students taught using JiTT and demonstration techniques.

- Students taught digital electronics using brainstorming teaching technique had higher mean retention scores than students taught using JiTT and demonstration techniques.
- There was significance difference between the cognitive achievement scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques**.**
- There was significance difference between the retention scores of students taught digital electronics using Brainstorming, Just-in-time and demonstration teaching techniques**.**

Discussion of Findings

Findings on the effects of brainstorming, JiTT and demonstration teaching techniques on students' cognitive achievement in digital electronics in colleges of education in North-West, Nigeria revealed that, brainstorming teaching technique had positive effects than demonstration and JiTT techniques. The findings indicated that, brainstorming teaching technique enhanced the cognitive achievement of students in digital electronics. The finding is related to the findings of Kholoud (2016) in his study on investigation of the effect of brainstorming strategy in Balqa Applied University's students' achievement in the course "E 101" (Physics) that revealed significant cognitive achievement of students taught Physics using brainstorming strategy. The positive effects of brainstorming teaching techniques on students' cognitive achievement in digital electronics could be due to the interactive nature of the technique that allow active participation of students in the learning processes. Claude *et al.* (2006) argued that, active participation in the learning processes enhances students' cognitive achievement. This implied that, teaching technique that allows interaction between students such as brainstorming techniques holds the potential of enhancing students' cognitive achievement.

Furthermore, findings on the test for significance difference among the cognitive achievement scores of students taught digital electronics using brainstorming, Just-in-time and demonstration teaching techniques revealed statistical significant. The statistical significant difference was traced to the group taught digital electronics using brainstorming teaching technique. The finding entails that, the group taught using brainstorming teaching technique was responsible for significance difference among the cognitive achievement scores of students taught digital electronics using brainstorming, Just-in-time and demonstration teaching techniques. The finding is similar to the finding of Wisdom *et al.* (2016) that revealed statistically significant difference between

the mean academic performance of students taught chemistry using brainstorming strategy and lecture method in South-South, Nigeria. This implied that, the brainstorming teaching technique is capable of causing huge difference in the cognitive achievement of students.

Findings on the effects of brainstorming, JiTT and demonstration teaching techniques on students' retention in digital electronics in colleges of education in North-West, Nigeria revealed that, brainstorming teaching technique had positive effects than demonstration and JiTT techniques. The findings entails that, brainstorming teaching technique enhanced the retention of students in digital electronics. The finding is related to the findings of Jacob *et al.* (2016) that revealed positive effect of brainstorming learning strategy on junior secondary school students' academic achievement and retention in social studies in Yola educational zone, Adamawa State, Nigeria. This could be due to the interactive nature of brainstorming teaching technique that allows active participation of students in the learning processes. Claude *et al.* (2006) contended that, students' participation during learning processes improves their level of retention. This connoted that, the teaching technique that allows students' interaction such as brainstorming technique is capable of enhancing students' retention.

Furthermore, findings on the test for significance difference among the retention scores of students taught digital electronics using brainstorming, Just-in-time and demonstration teaching techniques revealed statistical significant. The statistical significant difference was traced to the group taught digital electronics using brainstorming teaching technique. The finding is an indication that, the group taught using brainstorming teaching techniques was responsible for significance difference among the retention scores of students taught digital electronics using brainstorming, Just-in-time and demonstration teaching techniques. The finding is similar to the finding of Jacob *et al.* (2016) that revealed significant difference in the mean achievement and retention score of students taught social studies using brainstorming learning strategy and lecture method. This implied that, the brainstorming teaching technique is capable of causing huge difference in students' retention.

Conclusion

Based on the findings of the study, insights on the effects of brainstorming, JiTT and demonstration teaching techniques on students' cognitive achievement, skill achievement, interest and retention was provided. The study found out that, students taught digital electronics using: brainstorming teaching technique had positive effect on the cognitive achievement and retention of students in digital

electronics. The implication of the findings is that, the adoption of brainstorming teaching techniques hold the potential to enhance students' cognitive achievement and retention in digital electronics. Nevertheless, the findings are limited to the contents of digital electronics at college of education level in North-northwest, Nigeria. Therefore, it is concluded that, brainstorming teaching techniques had positive effects on students' cognitive achievement and retention in digital electronics.

Recommendations

Based on the findings from the study, the following recommendations were made:

1. Digital electronics lecturers should adopt the use of brainstorming teaching technique to enhance students' cognitive achievement and retention.
2. Digital electronics students should also embrace learning through the use of brainstorming teaching technique in order to enhance their cognitive achievement and retention.

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