EFFECTS OF JIGSAW AND GROUP INVESTIGATION METHODS ON STUDENTS' ACHIEVEMENT AND RETENTION IN BASIC ELECTRICITY IN NIGER STATE

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Abstract
This study was designed to determine the effects of jigsaw and group investigation method on students' achievement and retention in Basic Electricity (BE) in Niger State. Two research questions and two null hypotheses tested at 0.05 level of significance, guided the study. The study adopted a pre-test, post-test, non-equivalent control group, quasi-experimental research design. The population of the study was 390 NTC II students of BE in Department of EIMW Technical Colleges in Niger State. The sample of 150 students was used for the study, with 77 students in the jigsaw teaching method while 73 students in group investigation teaching method. Multi-stage sampling technique was used in the selection of two Technical Colleges in the State. The instruments used for data collection was Basic Electricity Achievement and Retention Test (BEART) which consists of 40 multiple-choice test items with four options. The BEART was pilot-tested to determine its reliability coefficient. Guttman Split-Half Coefficient of the instrument was found to be 0.77. Mean was used to answer the research questions; while ANCOVA was employed to test the hypotheses. The study found out among others that jigsaw teaching method was more effective in improving students' achievement and retention in BE than group investigation teaching method. Based on the findings of this study, it was recommended among others that EIMW teachers should adopt the jigsaw teaching method to teach students at technical colleges to enhance student's academic achievements and retention in Basic Electricity.

Keywords: Achievement, Retention, Jigsaw method of teaching, Group investigation.

Introduction

Technical colleges are institutions established for producing skilled manpower for actualising national development goals. It is one of the institutions established by Nigeria government where students acquire saleable skills, basic scientific knowledge and attitude in Technical Vocational Education and Training (TVET) that enable them to become self-reliant and reduce the rate of unemployment in the country (Federal Republic of Nigeria [FRN] 2014). According to Federal Republic of Nigeria (FRN 2014) TVET is a comprehensive term referring to those aspects of educational process involving in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life. The TVET system in Nigeria consists among others, Technical Colleges, Vocational Enterprise Institutions (VEIs) and National Vocational Qualifications Framework (NVQF), Innovative Diploma (FRN, 2014).

Technical colleges offer programmes in, electrical and electronics trades, which comprise the following: Electrical Installations and Maintenance Works (EIMW), Radio, Television and Electronics Work (RTEW) and Instrument Mechanics (IM), (NBTE, 2012). Electrical Installation and Maintenance Work is a broad field of study designed for the purpose of training students in order to meet up with the day-to-day needs of individual in Winding of Electrical Machines, Cable Jointing, Battery Charging, Domestic and Industrial Installation in an ever changing society (Ogbu, 2012). The scope of EIMW comprises the following modules: Winding of Electrical Machines (WEM), Cable Jointing and Battery Charging

(CJBC), Domestic and Industrial Installation (DII) and Basic Electricity (BE) (National Board for Technical Education (NBTE), 2001).

Basic Electricity is the focus of this study and it is a prerequisite to the other modules and it is one of the subjects required if students want to further their studies in Colleges of Education (Technical), Polytechnics and Universities of Technology. BE when taken successfully students should be able to use it for employment. This implies that students of BE from technical colleges should have the ability to maintain and install electrical appliances, equipment and devices and be able to carry out major and minor industrial and domestic wiring systems, design and calculate electrical circuit and loads, conduct routine maintenance, Troubleshoot and repairs electrical systems among others (Oghor & Osarumwense, 2015). Unfortunately, despite the good aims and objective of BE, studies have revealed that BEcraftsmen lack the necessary employable skills needed by electrical and electronics industries and are weak in practice of their trades (Muhammad, *et. al*. 2014). This could be as a result of teaching method adopt by technical college teachers in Nigeria.

In order to perform better than before and achieve the goals and objectives of EIMW there is need for effective teaching method to be employed in teaching the students. This is because teaching method is an approach applied in the classroom by the teacher focusing on student's achievement and retention in form of skill, knowledge, attitude and understanding. It has been revealed that the teaching method adopted in technical colleges in general and EIMW in particular are mainly teacher centred methods which include discussion, lecture and exploratory methods (Oghor & Osarumwense, 2015). Teacher centred methods is an approach where activities in the classroom are centred on the teacher and involves rote memorization and coverage of the context on the part of the students (Khalid &A zeem, 2012). Whereas, the problems in EIMW are problems that need creativity and innovation and involvement from both students and teachers.

In spite of the call from Federal Government of Nigeria for the shift from teacher centred method to students' centred method of teaching and learning at Technical Colleges in order to actualise the goals of technical education in Nigeria Federal Republic of Nigeria (FRN, 2014), teacher centred method is still the teaching method used in Technical Colleges. Studies have revealed that BE teachers still adopt teacher centred methods to teach the students (Shodeinde, 2013). These methods have been criticised by researchers as methods of teaching and learning which do not give room to students to actively involved in teaching and learning process in the classroom. It has led to poor academic achievement and retention of BE students (Ahmed, 2013). Not only that, the rapid development in electrical/electronics field have called for adequate teaching methods that is suitable to use in teaching BE students so that after graduating from technical college they should able to fit in electrical/electronics industry and also, able to face the challenges in this 21st century.

The 21st century needs people that are creative, innovative, can work in a team and bold enough to face challenges. Different researchers have also called for the shift from teacher centred method to student's centred method to meet up with the current development in both educational and industrial system. Series of researches have shown that student centred methods are more effective compared to teacher centred method, in improving student academic achievement and retention (Damodharan & Rengarajan, 2014; Federal Republic of Nigeria, 2014; Tumba, *et. al*, 2014). One of the students centre methods that could be used to prepare students for the over mentioned challenges are cooperative teaching methods. The cooperative teaching methods in question are Jigsaw and Group Investigation methods.

Jigsaw teaching method is cooperative activities that involve students to effectively teach each other with teacher's guidance. According to Aronson (2000) Jigsaw teaching method is a student centred method of teaching and learning employed where by students are grouped in the classroom and each student in the group is assigned his/her role to play. In jigsaw method students are grouped in two stages namely home group and expert group (Qiao & Jin, 2010). Also, in Jigsaw teaching method it is the responsibility of teacher to share students into different groups. Muhammad (2011) observed that Jigsaw teaching method allows students to share information with other groups, each student is accountable for the success of the group, learns a lot of material quickly and also helps to developing student's cooperative skills and develop their communication skill. Qiao & Jin (2010) stressed that when students are involved in solving problems it promotes their thinking capacity, increase their understanding of the content and give opportunity for better application of the knowledge. The home group is formed with the aim of assigning topic to each group member and discussing the topic in general while the expert group is formed with the aim of studying the subtopic and become more knowledgably in that aspect (Qiao & Jin, 2010).

Group Investigation is a cooperative method where students are grouped in only one stage. Compton (2015) defined group investigation (GI) as a cooperative teaching method where students are group in the classroom to work together in other to acquired skills, knowledge and understanding. GI make available an environment that reduces anxiety and allowed safe-risk taking and fear of making mistakes in BE (Baki, *et al*, 2010). GI entails the students to create small groups, to plan and carried out their investigations; synthesize the findings from the members of the group who then make presentations to the entire class (Baki, 2010). Asyik & Putri, (2016) says that the GI is one of the cooperative teaching method concentrates on the active involvement and participation of students. In GI class each group usually consists of 2-6 students and may form around an interest or around friendships. Students select the topics for study, then every group decides what sub-topics are to be investigated as well as the goals of their study and prepare and present a report in front of the class (Asyik & Putri, 2016).

However, there are lots of similarities and differences between Jigsaw and Group Investigation method as highlighted by (Samuel, 2018) which include: specified objectives, grouping of students', task division, critical thinking, collaborative and active learning, explanation, teacher monitoring and evaluation. However, the little difference between jigsaw and GI is that, jigsaw consist of two groups which are home group and expert group while GI consist of different groups in the classroom called (GI group). In addition, in jigsaw class teacher is saddled with the responsibility to group the students in to various groups unlike GI where students have the right to choose the group they wish to belong, teacher comes in when the group is not heterogeneous. Using jigsaw and group investigation method to teach BE in technical colleges could allow students to become more independent learners, giving them chance to contribute meaningfully in the classroom. Findings suggest that jigsaw and group investigation methods improve students' academic achievement (Samuel, 2018).

Achievement is regarded as the outcome of an action which is completed by hard work. Lassiter cited by Odeh, *et al*. (2015) referred to student academic achievement as the scores students have attained in either test or examination which determine their performance. Therefore, academic achievement refers to skills and knowledge attained by a student in school subjects, which is determined by a score obtained in continuous assessment. The student's achievement is also depending on ability or how long student can retained the

information. Retention is the capability to prompt performance and embrace such performance for periods of time (Atsumbe, *et al.,* 2015). They stressed that retention is the rate at which student perform in a subject's areas in terms of skills and knowledge acquired overtime. Therefore, retention is defined as the ability to retain or keep the knowledge acquired in basic electricity and to be able to recall it overtime when it is needed. Student's achievement and retention in the educational system depends on different factors. These include: socio-economic status of parent, gender, school location, method of teaching and others (Barry 2006; Eamon 2005; Eitle 2005; Chambers & Schreiber 2004).

Since there is a call to shift from teacher centred method to student's centred method in order to close the existing gab between the educational system and industrial demands there is need for adequate teaching methods. Therefore, studies have identified Jigsaw and Group Investigation methods in literature as possible methods that could be used in teaching BE module at technical college level and achieve the aims and objectives of technical colleges. The problem of this study is: What are the effects of Jigsaw and Group Investigation Methods on Students' Achievement and Retention in Basic Electricity in Niger State?

Research Questions

1. What is the effect of Jigsaw and Group Investigation method on students' achievement scores in Basic Electricity?
2. What is the effect of Jigsaw and Group Investigation Method on students Retention in Basic Electricity?

Hypotheses

The following null hypotheses are formulated to guide the study and was tested at 0.05 levels of significances:

Ho_1: There is no significance difference between the mean achievement scores of Basic Electricity students taught using Jigsaw Teaching Method and those taught using Group Investigation Method.

Ho_2: There is no significance difference between the mean retention scores of Basic Electricity taught using Jigsaw Teaching Method and those taught using Group Investigation Method.

Methodology

This study is a quasi-experimental research employing pre-test, post-test, non-equivalent control group design. This design is chosen in order not to alter the classroom organization already existing in the Technical Colleges in Niger State (Gall, Gall & Borg, 2007).

GROUP	NOTATION				
Experimental	O_1	X_1	O_2	Y	O_3
Control	O_1	X_2	O_2	Y	O_3

Where:

O_1= Pre-test for both experimental group 1 and experimental group 2
O_2= Post-test for both experimental group 1 and experimental group 2
$O_{3=}$ Retention test to be conducted after one week for both groups
Y= indicate a delay period of a week after post-test
X_1= Treatment with jigsaw method
X_2= treatment with group investigation method

The study was conducted in all the six technical colleges offering EIMW in Niger State. The target population for this study consists of all the 390 National Technical Certificate Two (NTC II)students who are taking Basic Electricity module in the Department of EIMW. The

sample size of 150 Basic Electricity students was selected for the study. A Multistage Cluster Sampling technique was used. Two technical colleges were selected randomly by balloting out of six technical colleges offering Basic Electricity in the state, the technical colleges are: The experimental group 1 (Jigsaw) is Government Technical College, EyagiBida while the Experimental group 2 (Group Investigation) is Sulaiman Barau Technical College, Suleja.

The instrument for data collection was Basic Electricity Achievement and Retention Tests (BEART)which consists of 40 multiple-choice test items with four options. The items of the achievement and retention tests were extracts from NABTEB examination past questions covered the selected topics considered in this study.

The Jigsaw and Group Investigation teaching lesson plans were developed by the researchers. The prepared lesson plans were used in teaching both the experimental group 1 and experimental group 2. Each of the lesson plans has at least two instructional objectives that were used to guide the lesson. Each lesson plan indicated among others, the lesson topic, specific objectives, previews knowledge, teaching aids and the instructional procedure. The instructional procedure showed details of the steps, introduction, students and teachers' activities, evaluation and summary. The table of specifications for the tests BEART was prepared and presented to three experts for face and content validation.

The instrument was pilot tested using split-half method on NTC II students taking Basic Electricity in Government Science Technical College, Garki, Abuja. The tests were splitted into odd and even numbers before analysis. The reliability of the BEART was determined using Guttman Split-Half Coefficient and was found to be 0.77. The software that was used for data analysis is the Statistical Package for Social Science (SPSS) IBM version 21. The scores that were obtained from pre-test and post-test were compared in terms of mean scores and standard deviation to answer research question 1 and 2. The pretest-posttest mean gain of each of the two groups were computed. While Analysis of Covariance (ANCOVA) on the SPSS was employed to test the hypotheses stated at 0.05 level of significance. The decision rule in answering the research questions was based on the mean gain score. Group with higher mean value irrespective of the closeness in the mean value of the other was taken to have performed better in achievement or retention test.

Results

Research question 1

What is the effect of Jigsaw and Group Investigation method on students' achievement scores in Basic Electricity?

Table 1: Mean of Pre-test and Post-test Scores of Students Taught BE Work in experimental group 1 and experimental group 2.

Group	N	Pre-test $\bar{x}$	Post-test $\bar{x}$	Mean Gain $\bar{x}$
Experimental group 1	77	21.58	34.97	13.39
Experimental group 2	73	21.77	32.74	10.97

*****N=Number of students, $\bar{x}$ =Mean

Table 1 show that the pre-test of the experimental group 1 means score is 21.58 while a mean score of 34.97 was gotten in the post-test. However, the pre-test, post-test mean gain of experimental group 1 was 13.39. The pre-test mean score of the experimental group 2 is 21.77 and a post-test mean of 32.74 while its pre-test, post-test mean gain is 10.97. It is revealed that experimental group 1 (jigsaw group) mean achievement score is greater than

the mean achievement score of the students in the experimental group 2 (group investigation method). Therefore, jigsaw teaching method is more effective than the group investigation method in improving the achievement of students in BE.

Research Question 2

What is the effect of Jigsaw (experimental group 1) and Group Investigation (experimental group 2) Method on students Retention in BE?

Table 2: Mean on theEffect of Jigsaw and GI Method on Students Retention in BE

Group	N	Post-test $\bar{x}$	Retention-test $\bar{x}$	Mean Gain $\bar{x}$
Experimental group1	77	34.97	36.44	1.47
Experimentalgroup2	73	32.74	33.27	0.53

Table 2 shows that the jigsaw teaching method is more effective than the group investigation in improving the academic retention of students in EIMW. The jigsaw group (experimental group1) had a mean score of 34.97 in the post-test and a mean score of 36.44 in the retention test, while the post-test, retention test mean-gain in jigsaw group was 1.47. The group investigation (experimental group2) post-test mean score was 32.74 and the mean of retention test was 33.27, while the mean-gain from post-test, retention test was 0.53. Based on the use of jigsaw and group investigation methods in teaching BE revealed that there was a significant difference in favour of jigsaw group. The result revealed that, retention mean score of jigsaw group is greater than the mean retention score of the students in the group investigation. Therefore, jigsaw method is more effective than the group investigation in improving the academic retention of students in BE.

Hypothesis 1

Ho_1: There is nosignificance difference between the mean achievement scores of BE students taught using Jigsaw Teaching Method and those taught using Group Investigation Method.

Table 3: **Summary of Analysis of Covariance (ANCOVA) for Test of Significant Difference between the Mean Achievement Scores of BE students taught using Jigsaw Method and those taught using Group Investigation Method**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	190.236[a]	13	14.634	1.643	.081
Intercept	1569.195	1	1569.195	176.146	.000
Posttest	14.828	1	14.828	1.665	.199
Group	160.648	12	13.387	1.503	.130
Error	1211.558	136	8.909		
Total	168669.000	150			
Corrected Total	1401.793	1149			

a. R Squared = .136 (Adjusted R Squared = .053)

* Significance (F calculated is higher than .05)

Table 3 revealed the F-calculated values for mean scores of jigsaw and group investigation method on the achievement test of BE. The result revealed that the F-calculated value for Group is 1.503 with p-value of 0.130 is greater than .05. Therefore, do not reject the null hypothesis. With this result, there is no significant difference in the mean achievement scores of BE students taught using Jigsaw Teaching Method and those taught with Group Investigation Method.

Hypothesis 2

Ho_2: There is no significant difference between the mean retention scores of BE students taught using Jigsaw Teaching Method and those taught using Group Investigation Method

Table 4: **Summary of Analysis of Covariance (ANCOVA) for Test of Significant Difference between the Retention Mean Scores of Students Taught BE Using Jigsaw teaching methods and Those Taught with Group Investigation teaching method**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	283.811[a]	13	21.832	2.018	.024
Intercept	1655.874	1	1655.874	153.065	.000
Posttest	5.710	1	5.710	.528	.469
Group	257.336	12	21.445	1.982	.030
Error	1471.263	136	10.818		
Total	174001.000	150			
Corrected Total	1755.073	149			

a. R Squared = .162 (Adjusted R Squared = .082)

* Significance (F calculated is less than .05)

Table 4 shows that jigsaw and group investigation methods as the main effect is significant to students' retention in BE. This is revealed by the calculated F-value of 1.982 and p-value of 0.030 is less than 0.05. Therefore, the null hypothesis of no significant difference is rejected. This indicates that there was a significant difference in the mean retention scores of BE students taught with Jigsaw Teaching Method and those taught using Group Investigation Method.

Discussion of Findings

The findings on the effect of Jigsaw and Group Investigation method on students' achievement scores in BE shows that the mean achievement in the jigsaw group is higher than the GI group. This implies that students in the jigsaw group had a higher mean gain compared to their counterparts in the GI group after treatment. The finding supported the results of Gambari *et al.* (2017) who reported that exposing students to jigsaw II cooperative learning strategy increases students' achievement than STAD and TAI cooperative learning strategy. Karacop (2017) stresses that jigsaw and group investigation methods significantly improved students' academic achievement than confirmatory laboratory method. In the same way the finding of this study confirmed the findings of Adejoh (2015) who found out that Jigsaw Instructional Techniques increased academic achievement of students' in graph related concepts in Economics than those taught with group investigation instructional strategies. In addition, Mbako (2013) also discovered that students' taught using jigsaw learning strategy performed better in terms of academic achievement compared to the students' taught using conventional teaching methods. The possible reasons behind the improvement of jigsaw method over group investigation method is as a result of the expert group which helps each student to be a master of his/her task and become a teacher to his home group. Also, the groups were formed by the class teacher and topics were evenly distributed. Each student was giving right over his/her task, with that they will do everything possible to ensure that they belong to the group.

The summary of Analysis of Covariance (ANCOVA) for the test of significant difference between the achievement mean scores of students taught BE using Jigsaw Teaching method and those taught with Group Investigation teaching method the study found out that there

was no significant difference between the mean score of jigsaw and group investigation groups in the achievement of students in BE. This is because, F-calculated value (1.503) and p-value of (0.130) for the effect of teaching method on the academic achievement of BE students taught using jigsaw and those taught with group investigation method is higher than .05. Therefore, the null hypothesis was accepted. The findings of the study confirm with the study conducted by Adejoh (2015) that there was no significant difference in the mean achievement scores between the students who learn Economics using Group Investigation method with those taught using Jigsaw Instructional Techniques. Jigsaw and group investigation methods are cooperative learning methods which have almost similar treatment in the class. This implies that the two methods were significantly effective on the students' achievement in teaching and the learning of BE. When students centred method is used in teaching BE students are actively involved in teaching and learning process in the classroom. Students are accountable to the success of their groups. Finally, students have the ability to construct and search for the knowledge and teach their group members.

The findings on student retention based on the use of jigsaw and group investigation methods in teaching BE revealed significant difference. Therefore, it can be concluded that the use of jigsaw teaching method in enhancing student retention in BE is most effective than group investigation method, because the mean gain of students taught with jigsaw teaching method is greater than students taught with group investigation method. The findings of this study confirmed the findings of Tran (2016) who revealed that students who were taught using jigsaw cooperative learning obtained higher retention mean scores in the retention test compare with those taught using lecture method. This finding agreed with the results of Sahin (2010), which shows that jigsaw III technique increases students' academic retention than conventional teaching method. This is because; there is little differences in the treatment that student in jigsaw group received. The jigsaw process in the treatment group required students to study and learn the assigned task by moving from home groups to join other students with the same task in expert groups where they help each other to learn their assigned task and become more knowledgeable on it, and move back to their home group where they teach other members what they learned. Therefore, students were able to retain knowledge by sharing and exchanging of information and materials and the supportive discussion held by students in the group. Though, the two teaching methods are effective in teaching BE in technical colleges but jigsaw teaching method is more effective.

The findings on the test of significance difference between the student learning retention based on the use of jigsaw and group investigation methods in teaching BE revealed that there was a significant difference in favour of jigsaw group. This is because, F-calculated value (1.982) and p-value of (0.030) for the effect of teaching method on the academic retention of BE students taught using jigsaw and those taught with group investigation method is less than .05. The null hypothesis was rejected. Clearly, the different treatment students were subjected to was the foundation for the significant difference in the students retention. However, the finding is similar with the study of Samuel (2018), who found out that there was a significant difference in the mean scores of students exposed to Jigsaw IV, group investigation, reversed jigsaw and conventional demonstration method. The finding of this study is similar to the findings of Koç*et. al.* (2013) whose study revealed that there was a significant difference in favour of the "learning together" method which is students' centred method in terms of academic retention gained in Science and Technology laboratory. Since every student in jigsaw group is assigned his/her task to work on which makes them to be responsible for a small part of the learning activity in the classroom, it enhanced students to study better since they are accountable to other group members.

Conclusion

The call for shift from teacher centred method to student's centred method in teaching and learning of BE in technical colleges in particular and education system in general, is significant in the educational system of Nigeria. Therefore, this study examined two types of cooperative teaching methods (Jigsaw and GI) as a way to move from teacher centred method to students' centred method and to improve the students' academic achievement and retention in teaching BE in technical colleges. The result of the study revealed that the two cooperative methods had positive effects on student's achievement and retention on BE students. However, jigsaw teaching method is more effective in enhancing students' achievement and retention of knowledge in BE than group investigation teaching methods.

This research work has contributed immensely to knowledge in view of the current challenges confronting the nation's technical colleges with respect to teaching methods. Consequent upon this therefore, this study has filled the gap in the teachers centred method adopted in teaching students in technical colleges and has shifted to student's centred method. From the result of this study jigsaw and GIare students' centred methods introduced by the researchers. Jigsaw and group investigation method which is based on the principles that enable students to search and construct their knowledge and become self-reliant and overcome the fear of making mistakes, as is being experienced in basic electricity.

Recommendations

Since there is call to shift from teacher centred method to students centre methods of teaching and learning in other to produce graduates who are creative, work in a team, innovative, take risk and can fits in to this 21st century challenges. The following recommendations were made based on the findings of the study:

1. Electrical Installation and Maintenance work teachers should adopt jigsaw teaching method to teach students at technical colleges to enhance student's academic achievements and retention in EIMW. Since it is a cooperative teaching method and a students' centred method which is suitable for imparting knowledge to students in order to face this 21st century challenges.
2. National Board for Technical Education should carry out a review of EIMW trade curriculum for Technical Colleges with aim to include jigsaw teaching method for teaching of EIMW.
3. Regular workshop and seminar should be organized for EIMW teachers by State Ministries of Education on the needs for the teachers of using jigsaw teaching method.

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