EFFECTS OF GUIDED DISCOVERY METHOD OF TEACHING ON STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK IN GOVERNMENT SCIENCE AND TECHNICAL COLLEGES OF ADAMAWA STATE

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Abstract
The study investigated the effects of guided discovery method of teaching on students' academic achievement and retention in electrical installation and maintenance work in government science and technical colleges of Adamawa state. A pre-test – post-test nonequivalent control group quasi experimental research design was adopted for the study. Two intact classes from two technical colleges were selected. The whole population of 84 NTC II students was used for the study. Two research questions and two hypotheses were formulated to guide the study. Electrical Installation and Maintenance Work Trade Achievements Test (EIMWAT) was used to collect data for the study. The instrument was validated by three experts in the department of Electrical Technology Education, Modibbo Adama University of Technology, Yola. To determine the reliability of the instrument, split-half method of establishing reliability was used. Spearman Brown was used to compute the reliability and a reliability coefficient of 0.95 was obtained. Mean statistics was used to answer the research questions while the null hypotheses were tested using t-test at 0.5 level of significance. Findings of the study revealed that students obtained high achievement scores when taught electrical installation and maintenance work trade using guided discovery method of teaching than the lecture method. It further revealed that students' mean score in a delayed posttest to test their retention level was higher in the Guided discovery method of teaching electrical installation and maintenance work trade than lecture method. The study concluded that the use of guided discovery for teaching electrical installation and maintenance works in technical college enhanced better academic achievement that the lecture method of teaching. The study recommended among others that Curriculum planners and school administrators should encourage the use of and incorporate guided discovery method of teaching into the curriculum as a method of teaching electrical installation and maintenance work trade.

Keywords: Guided Discovery, Method of Teaching, Academic achievement, Retention, Electrical Installation and Maintenance Work, Technical Colleges

Introduction
The primary purpose of teaching at any level of education is to bring a fundamental change in the learner. To facilitate the process of knowledge transmission, teachers are expected to apply appropriate teaching methods that best suit specific objectives and the expected learning outcomes. In the traditional epoch, many teaching practitioners widely apply teacher-centered methods to impart knowledge to learners as compare to student-centered methods (Tebabal& Kahssay, 2011). For some time now researchers have continue to ask questions about the effectiveness of teaching methods on student learning and this has consistently raised considerable interest in the field of technical educational research (Hightower, 2011).

According to Enemali (2006), teaching method refers to the general principles and management strategies used for classroom instruction. The methods adopted by the teacher would determine the success or failure of the lesson which either sharpen the mental actives or discourage initiatives and curiosity of the student. To buttress the importance of teaching methods, Ayeni (2011) asserted that, teaching is a continuous process that involves bringing about desirable changes in learners through the use of appropriate methods. In support of the above view, Adunola (2011) opined that, in order to bring desirable changes in students, teaching methods used by teachers should be appropriate for the subject matter. Furthermore, teaching methods work effectively if they suit the learners' need since every learner interprets and responds to questions in a unique way. As such, alignment of teaching methods with students' needs and preferred learning, influence students' academic achievement (Bello, 2000).

Omiko (2017) observed that, the changes in education curriculum in recent years has led to consequent shift of emphasis from the traditional chalk and talk (conventional) method to modern methods of teaching science and technical subjects at the secondary school level such as activity oriented method of instruction, laboratory method, concept-mapping, enquiry method and guided discovery method among others. In these modern methods of instruction, emphasis is on changing students' attention from being passive receivers of information to active manipulators and users of concrete materials during instruction. This means that the students are involved actively in the learning process by themselves as in the guided discovery method of teaching (Bello, 2002).

Guided discovery is a student-centered strategy of teaching whereby students interact actively in the learning process. This method encourages students to engage in asking questions and students' assumptions on issues are made clearer and provide their view points on any area of the subject matter. It is accomplished through investigations at the students' own rates and level of ability which makes learning to take place. Guided discovery emphasizes higher-level thinking skills. According to Wilson, Taylor, Kowasky and Carison (2010) the teacher uses this strategy to present concrete experiences of authentic problems. The teacher asks lots of questions and uses speculative statements with many speculative interactions designed to raise issues for students' discussion. In another vein, Anbessa (2012) guided discovery is generally regarded as a motivating method, enjoyed by students. Anbessa suggested that students are motivated by total participation in the lesson. Ezejitu (2009) noted that most activities of young children are underlined by tireless curiosity and a desire to find out through personal exploration. Discovery according to Otobo (2012) is a psychological construct that is based on the need to provide relevant motivation for students to participate in the generalization of new ideas related to the subject of instruction. Omiki (2017) states that discovery occurs when a learner is involved in utilizing his/her mental processes and physical activity to mediate, discover, or grasp some principles, concepts or ideas in various situations. Generally, in teaching and learning situations, guided discovery method of teaching is a problem solving method that is meant for self-development and sustainability. It enables the learners to identify an objective, plan for its actualization with a little help and guidance from the teacher (Ezejitu, 2009 and Otobo, 2012).

According to Umar (2015), academic achievement describes a measure or level of success in relation to a task or job**;** especially, learning that has been carried out. Artherton (2003) maintained that academic achievement is hinged on several factors including, teaching method, motivation, teaching aids, interest of the learner, and other environmental variable. Lowman (2006) stressed that, studies have been conducted to articulate the characteristics of a good teaching and how it relates to students' academic achievement. Lowman stated that the methods and tools employed by a teacher to impact the lesson could lead to students' learning, higher retention and higher academic achievement in educational institutions.

Retention according to Momoh-Olle (2007) simply means how much a person remembers after an interval of time without practice; and that is the difference between what is initially learnt and what is later forgotten. Retention in learning also refers to as learning which last long beyond the initial testing and it is assessed with the same test administered later after the initial test has been administered (Haynie, 2013). The period between the completion of training and subsequent performance of the trained skill is conventionally referred to as the retention interval (Oloyede & Adekunle, 2009). Retention could be explained as the process or ability to retain and remember things, and experiences learned by an individual at a later time. However, retention occurs when experience are coded in the memory. Experiences such as the practical skills training in technical colleges in different technical trades can be retained when students are exposed to effective teaching method.

Electrical Installation and maintenance work (EIMW) is one of the Electrical engineering trade offered at both the National Technical Certificate (NTC) and Advance National Technical Certificate levels in Government Science and Technical Colleges. The trade is geared toward equipping its beneficiaries with knowledge and skills in electrical installation and maintenance practice at craft level. According to the National Policy on Education of the Federal Republic of Nigeria (FRN) (2016), the philosophy behind the establishment of the National Technical Certificate (NTC) programme in Nigeria is to train Technical College Students with the necessary knowledge and skills that could lead to the production

of craft men and other skilled personnel who could filled up vacancies of craft level personnel in Nigeria's industrial and business sector. EIMW course is run by Government Science and Technical College that have been accredited by National Board for Technical Education (NBTE) and examined by National Business and Technical Education Board (NABTEB).

Statement of the Problem

Electrical installation and maintenance works trade offered at the National Technical Certificate level in technical colleges is meant to prepare students with the requisite skills that can make them to be self-reliant after graduation. The Federal Republic of Nigeria, FRN (2014) categorically stated that the main objective of the programme at that level is to produce skilled graduates who may choose to practice their skills or proceed to higher institutions of learning. Unfortunately, for some time now in Adamawa state, the performance of students both at the level of practical skills possessed and academic achievement at Senior School Certificate has persistently been poor especially in external examinations like the SSCE and NABTEB. This is evident in the fact that after graduation most of these students resort to be tricycle operators while some of them go back to repeat secondary school. This is unacceptable and should be a matter of concern to all stakeholders.

Researchers such as Duhu (2007) and Fatokun (2007) have identified several factors responsible for students' poor performance in Technical subjects and they classified these factors as students-related factors, teacher-related factors, society-related factors and government-related factors. Among other things that form the teacher-related factors is the teaching methods adopted by teachers to teach practically-oriented courses like those obtained in technical colleges. (Duhu, 2007) has observed that teachers of electrical installation and maintenance works trade like other teachers in other disciplines do not show their ability to be flexible in making use of variety of teaching methods to teach EIMWT in technical colleges. Most of them stick to a particular method they are conversant with. The predominant teaching method used is the lecture method which can not necessarily impact the requisite skills and knowledge on the students. Modern instructional methods which are student-centered such as guided discovery have been proved to better enhance students' performance in sciences (Garuma and Tesfaye, 2012). It is a problem solving method meant for self development and sustainability. It enables the learner to identify an objective, plan for its actualization with little help and guidance from the teacher, (Ezejitu, 2009). However, it is not quite certain whether this strategy can be effective for teaching technical subjects like electrical installation and maintenance works in technical colleges. The search for knowledge to improve teaching and learning at all levels of education should and will continue to be a matter of interest to stakeholders in education. It is against background that the researchers found out by empirical means the efficacy of guided discovery method of teaching on students' performance and their level of retention of learned material when taught using guided discovery in Government science and technical colleges in Adamawa state.

Purpose of the Study

The main purpose of the study is to determine the effects of guided discovery methods of teaching on students' academic achievement and retention in electrical installation and maintenance work in government science and technical colleges of Adamawa state. Specifically, the study sought to:

1. Compare students' mean achievement scores in electrical installation and maintenance work trade when taught using guided discovery and lecture methods of teaching.
2. Compare the mean score of the guided discovery group and the lecture method group after a delayed posttest in electrical installation and maintenance work trade.

Research Questions

This research work answered the following questions:

1. What is the difference between students' mean achievement scores in electrical installation and maintenance works when taught using guided discovery and lecture methods of teaching?
2. What is the difference between the mean score of the guided discovery group and the lecture method group after a delayed posttest in electrical installation and maintenance work trade?

Hypotheses

H_{01} There is no significant differences between students' mean achievement scores in electrical installation and maintenance work when taught using guided discovery and conventional methods of teaching.

H_{02} There is no significant difference between the delayed achievement scores of students when taught electrical installation and maintenance work using guided discovery and lecture methods of teaching.

Methodology

The study adopted pre-test – post-test nonequivalent control group quasi experimental research design. According to Cohen, Manion and Morrisom (2007), quasi-experimental design is employed only when randomization was not possible and it is typically easier to set up than real experimental design. Similarly, to use a natural classroom setting for experimental research without random assignment, a nonequivalent group design of Quasi-experimental is considered more appropriate (Sambo, 2005). The conceptual model of the design is presented as follows:

E: O_1 X_1 O_2

C: O_3 X_2 O_4

O_1= Pre-test score of the experimental group; O_3= Pre-test score of the control group;

O_2= Post-test score of the experimental group; and O_4= Post-test score of the control group

X_1= experimental treatment group; X_2= control treatment group;

Guided discovery method of teaching was used for experimental group while lecture method was used for control group. The area of this study is Adamawa state. Adamawa state has three Government-owned technical colleges. They include GSTC Yola, Mubi and Numan. The three technical colleges are state-owned schools and so assumed to have the characteristics in terms of equipment, teachers and quality of students. The population of the study comprised the entire 137 NTCII Electrical Installation and maintenance Works (EIMW) in 2019/ 2020 session in the three Technical colleges in Adamawa state. However, a purposive sampling technique was used to select two Government Science and Technical Colleges from the study area. They were Government Science and Technical College, Yola and Government Science and Technical College, Numan. The sample for the study was intact classes of NTC II EIMWT in Yola and Numan with Yola having 53 students and Numan having 31 students. The researcher used the entire population of NTCII EIMW students of the two schools (84 students) as sample size for the study because the population was manageable.

An instrument titled" Electrical Installation and Maintenance Work Trade Achievements Test (EIMWAT)" developed by the researcher was used for data collection. EIMWAT was used for both pre-test and post-test to collect data for the study. The instrument was validated by five specialist, three from the department of Electrical technology Education, Modibbo Adama University of Technology, Yola, and two from GSTC, Yolain Adamawa State. Split-half method of establishing reliability was used to find the reliability and Spearman-Brown formular was used to compute the reliability which yielded a reliability index of 0.95.

The data for the study was collected through the administration of pre-test, post-test and delayed achievement tests in some selected topics in electrical installation and maintenance works of the NTCII syllabus. Mean was used to answer research questions, while t-test was used to test the hypothesis at 0.05 level of significance. The decision was such that, if the p- value was greater than the alpha level of 0.05, the null hypothesis was considered significant and if otherwise was considered not significant.

Results

Research Question 1: What is the students' mean achievement scores in electrical installation and maintenance work trade when taught using guided discovery method of teaching.

Table 1: Mean and Standard Deviation of EIMWT Students' Academic Achievement Taught Using Guided Discovery Method

Methods	N	×	SD	Mean difference	Remarks
Guided discovery		44	77	6.95	
Lecture method	40	52.2		6	24.8 High

Table 1 showed the post-test mean achievement scores of the experimental group and the control group. The experimental group has a posttest mean score of 77% while the lecture method has a posttest mean score of 52.2%. The mean difference between the two groups is 24.8%. Thus, the experimental group with mean of 77% has performed better their counterparts in the lecture method. The mean difference of 24.8% is high.

Research Question 2: What is the difference between the mean score of the guided discovery group and the lecture method group after a delayed posttest in electrical installation and maintenance work trade?

Table 2: Mean and Standard Deviation of Guided Discovery and lecture group in delayed Posttest

Methods	N	$\bar{x}$	SD	Mean Gain	Remark
Guided discovery	44	69.5	6.14		
				14.8	High
Lecture method	40	46.7	7.21		

Table 2 showed the delayed achievement test (retention level) of the experimental group taught using Guided Discovery and the control group taught using lecture method. The delayed test was administered to assess their level of retention of learned material. It was administered after an initial period of three weeks. From the table it could be seen that the students in the guided discovery group has a mean score of 69.5% while those from the lecture group has a mean sore of 46.7%. This implies that the retention level of students taught using guided discovery was higher than their counterpart in the lecture method group.

Hypothesis 1: There is no significant differences between students' mean achievement scores in electrical installation and maintenance work trade when taught using guided discovery and Lecture method of teaching.

Table 3: t- test Comparison of Post-test Mean Achievement Scores of Students in Electrical Installation and Maintenance Work When Taught Using Guided Discovery and lecture Method

Teaching Method	N	$\bar{x}$	Σ	df	t	P-Value	Remark
Guided Discovery (Experimental)	44	77.00	6.95				
				82	19.96	0.000	Rejected
Lecture (Control)	40	52.18	5.97				

N= Number of Students, $\bar{x}$ = Means Scores, σ = Standard Deviation, df = Degree of Freedom

Table 3 presents the t-test analysis of hypothesis one. The results show that the experimental group taught using guided discovery had a mean achievement score of 77.00 and standard deviation of 6.95 and the control group taught using lecture method had a mean achievement score of 52.18 and standard deviation of 5.97. The p-value is $p=0.000 < 0.05$ at 82 degree of freedom. Thus, as p-value is less than the alpha value of 0.05, the null hypothesis is rejected. This means that there is significance difference between the mean achievement scores of the experimental and control groups.

Hypothesis 2: There is no significant difference between the mean score of students of the experimental and the control groups in a delayed posttest on electrical installation and maintenance work trade achievement test

Table 4: t- test Comparison of Delayed Mean Achievement Scores of Students in Electrical Installation and Maintenance Work When Taught Using Guided Discovery and lecture Methods

Teaching Method	N	$\bar{x}$	Σ	df	t	P-Value	Remark
Guided Discovery (Experimental)	44	69.50	6.14				
				82	9.310	0.000	Sig.
Lecture (Control)	40	46.72	7.21				

N= Number of Students, $\bar{x}$ = Means Scores, σ = Standard Deviation, df = Degree of Freedom

Table 4 presents the t-test analysis of hypothesis two. The results show that the experimental group taught using guided discovery had a mean achievement score of 69.50 and standard deviation of 6.14 and the control group taught using lecture method had a mean achievement score of 46.72 and standard deviation of 7.21. The p-value is $p=0.000 < 0.05$ at 82 degree of freedom. Thus, as p-value is less than the alpha value of 0.05, the null hypothesis is rejected. This means that there is significance difference between the mean achievement scores of the experimental and control groups in a delayed posttest.

Findings of the Study

Based on the results analyzed and presented in tables, the following findings were made:

1. Students' obtained high achievement scores when taught electrical installation and maintenance work trade using guided discovery methods of teaching than lecturel lecture method
2. Guided discovery methods of teaching increases students' retention when used in teaching electrical installation and maintenance work trade than lecture method
3. There was significant difference in the mean achievement scores of electrical installation and maintenance work trade students when taught using guided discovery and lecture methods of teaching ($t_{82,0.05} =19.96$, $p<0.05$).
4. There was significant difference in the retention mean scores of electrical installation and maintenance work trade students when taught using guided discovery and lecture methods of teaching ($t_{82,0.05} =9.310$, $p<0.05$)

Discussion of Findings

The study revealed that, students' obtained high achievement scores when taught electrical installation and maintenance work trade using guided discovery methods of teaching than conventional method . This finding is in agreement with Obioma (2007) who investigated the effect of two teaching methods, conventional and guided discovery on students' academic performance in physics. Obioma observed that students who were exposed to guided discovery lesson perform better than their counterparts who were taught using conventional method of teaching. Furthermore, to support this finding, Udo (2010) investigated the relative effectiveness of problem-solving, guided discovery, and conventional methods of instruction on students' performance in redox reaction. The study revealed that students taught using guided discovery performed excellently in their individual tasks while problem-solving follow behind and the conventional method was trailing at the rare. This finding is also in agreement with Garuma and Tesfaye (2012) who stated that students' performance in guided discovery is enhanced as the method provides avenue for individual participation and interpretation in the mind of the learner. Garuma and Tesfaye further maintained that students' expose to guided discovery method of teaching will always perform better in their academic achievement.

The findings of the study further revealed that guided discovery method of teaching increases students' retention when used in teaching electrical installation and maintenance work trade than conventional method. The improvement in retention could be as a result of committing more senses in the teaching and learning process. According to Enemali (2002), people remember 20% of what is heard, 30% of what is seen and 50% of what is seen and heard at the same time. The use of instructional media was responsible for the high retention of the student's in guided discovery group. The finding is also in agreement with Ogwo, (2006) who pointed out that the use of media increased knowledge content retention through constant engagement. Similarly, Ukeje (2001) also pointed out that the use of educational media improves retention in teaching learning process. This finding concur with Nwachukwu (2006) who asserted that in using conventional teaching method, low academic retention is recorded in learners as the learner's interaction with the teaching aids are usually restricted. Students are not given the free hand to handle the available instructional materials as a result of that the student loss whatsoever idea he may have gathered during the lesson.

The study revealed that there was significant difference in the mean achievement scores of electrical installation and maintenance work trade students when taught using guided discovery and demonstration methods of teaching ($t_{82,0.05} =19.96$, $p<0.05$). This finding is in agreement with Udo (2010) who reported that those taught using guided-discovery method performed significantly better than those taught with problem-solving and conventional methods. Similarly, Ormerod (2005)

reported that there was significant difference between study taught physics using guided discovery and conventional methods of teaching.

The finding of the study revealed that there was significant difference in the retention mean scores of electrical installation and maintenance work trade students when taught using guided discovery and demonstration methods of teaching ($t_{82,0.05}$ =9.310, $p<0.05$). The finding is in agreement with Okoro (2003) who reported that there was significant difference between there was significant difference in the retention mean scores of physics students when taught using guided discovery and conventional methods of instruction.

Conclusion

The study concluded that when students are taught electrical installation and maintenance work trade using guided discovery, they performed better than when taught using conventional method. It was also concluded that when students were taught electrical installation and maintenance work trade using guided discovery, they retained what was learnt for a longer period than when they are taught using the conventional

Recommendations

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

1. Curriculum planners should incorporate guided discovery method of teaching into the curriculum as a method of teaching electrical installation and maintenance work trade in GSTCs as it has been established that guided discovery method enhances students' performance.
2. The management of government science and technical colleges should ensure that teachers conduct regular retention achievement test on the student of electrical installation and maintenance work trade in order to establish the level of their retention.
3. Government should organized workshops for EIMWT teacher on the effective use of guided discovery method of teaching

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