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Effect of Inquiry and Challenge-Based Instructional Strategy on Student Learning Outcomes in Electrical Installation and Maintenance Work in Niger State

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Abstract

The study investigated the effect of inquiry and challenge-based instructional teaching techniques on student learning outcomes in electrical installation and maintenance work in technical colleges in Niger State. Two research questions and two null hypotheses guided the study. The study adopted the use of Quasi-experimental design. The study was conducted in all the technical colleges in Niger State, Nigeria. The targeted population for this study was 181 NTC II students who are taking electrical installation and maintenance work in the seven technical colleges in Niger State. The instrument that was used for data collection was Electrical Installation and Maintenance Work Achievement Test (EIMWAT). The instruments were subject to face and content validation by two experts in Department of Industrial and Technology Education, Federal University of Technology Minna, Niger State and one expert from Government technical college, Minna Niger State. The reliability coefficient of the instrument was found to be 0.725 using Cronbach Alpha Statistics. Data collected for the study, was analysed using Statistical Package for Social Science (SPSS). Descriptive and inferential statistics was used to analyse the data. The findings revealed that the challenge-based instructional teaching techniques achievement test score is higher than the achievement score of inquiry-based instructional teaching techniques. Based on the findings it was recommended that the National Board for Technical Education (NBTE) should consider a review of electrical installation and maintenance work curriculum for Technical Colleges with a view to incorporating the challenge-based instructional teaching techniques into the teaching of electrical installation and maintenance work.

Keywords: Technical Colleges, Electrical Installation and Maintenance Work, Instructional Teaching Techniques, Challenge Based Learning (CBL), Inquiry-Based Learning (IBL), Learning outcomes, and Academic Achievement.

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Introduction

Technical colleges refer to senior secondary education designed to provide technical skills and vocational education required to complete the tasks of a specific job. Ubanwa *et. al.*, (2022) explained that technical colleges are institutions established and saddled with the responsibility for training of craftsmen in Nigeria. Technical colleges are post-basic level institution for training of craftsmen and master craftsmen. The technical college courses lead to the award of the National Technical Certificate and Advanced National Technical Certificate (ANTC) for technical courses and the National Business Certificate (NBC) and Advanced National Business Certificate (ANBC) for business studies (Kazaure, 2018). The goals of technical colleges, as stated by Federal Republic of Nigeria, FRN, (2014) are, to provide trained manpower in the applied sciences, technology and business, particularly at advanced craft level. Technical levels provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development; and to give training and impart the requisite skills to individuals who shall be self-reliant economically and in tune with latest technology.

Electrical Installation and Maintenance Work (EIMW) is one of the programmes offered in technical colleges that develop intermediate-level skills in electrical and electronics related trade areas. According to the National Board for Technical Education (NBTE, 2011), the main goal of electrical installation and maintenance work is to produce competent electrical/electronic technicians and teachers who are skilled to conduct various types of electrical and electronics installations, diagnose, repairs and maintenance. The program is expected to give the students technical skills and competencies in working with electrical and electronic devices in order to grantee them to work in industry or to become electrical installation and maintenance work teacher. The goal of electrical installation and maintenance work can only be attained by selecting appropriate Instructional teaching techniques.

Instructional teaching techniques refer to systematic processes based on scientific knowledge employed in teaching. Dokadawa (2019) explained instructional teaching technique as the procedure. Instructional teaching techniques refer to the teaching method that electrical installation and maintenance work teacher adopt in organizing their students, materials and ideas to provide learning. As such instructional techniques play vital roles of promoting active engagement and

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participation of electrical installation and maintenance work students in teaching –learning process which can result to enhancing teaching. There are difference instructional techniques which can be used in different ways for efficient and effective teaching and learning. These techniques are conventional method, lecture method, field trip, project based, laboratory, experiments, demonstration, inquiry-based, challenges-based among others.

Challenge-based instructional teaching technique is one of the teaching pedagogical approaches that actively engages students in a situation that is real, relevant and related to their environment. Badde *et al.,* (2023) postulated that Challenge-based instructional technique is an immersive, multidisciplinary approach to teaching and learning that allows students to use technologies to solve real-world challenges in their everyday lives. Challenge-based instructional teaching techniques in the content of this study is a learning techniques in which electrical installation and maintenance work students learn through facilitated problem-solving. The basic tenet of challenge-based instructional teaching technique is that learning is motivated by difficult open-ended issues with various answers. It gives a practical and efficient framework for learning while addressing real-world problems. The framework fosters cooperation in order to develop significant ideas, ask probing questions and identify, explore and solve problem. This type of learning approach is student-centered teaching techniques which create opportunity for students to explore their own interests and thinking creatively, inspiring more original and innovation ideas.

Inquiry-based instructional technique is one of the student-centered instructional techniques that encourage students to ask questions and investigate real world problem. Gavric & Radivojevic (2022) stated that inquiries, as a new method of teaching science was proposed to teachers in order to present science to students in the form of an examination. Therefore, Inquiry-based instructional teaching techniques can be defined as the art of questioning. The method is usually used during the realization of scientific content and consists of five steps: engagement, research, explanation, elaboration and evaluation. Inquiry-based instructional techniques in the content of this study are learning process that engages electrical installation and maintenance work students by making real-word connection through explorations. The ultimate aim of any instructional teaching techniques process is that the students achieve the desired learning outcomes.

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Learning outcomes can be viewed as measurable skills, knowledge, abilities and what students should be able to demonstrate as a result of a completing a course. According to Badde *et al*., (2023) learning outcomes are behaviors that students can perform after the learning has taken place. Learning outcomes in the content of this study are the knowledge, skills abilities and attitudes that electrical installation and maintenance work students are expected to attain by the end of a learning outcomes.

Academic achievement can be regards as academic outcomes that indicates the extent to which a student has achieved their learning outcomes. Oviawe (2021) explained academic achievement as the extent of accomplishment or failure of goal in a particular content that the student has earlier been exposed to. Academic achievement in the content of this study is the extent to which electrical installation and maintenance work has achieved either in short or long term educational goals.

Electrical installation and maintenance work as offered in technical college in Nigeria are poised with the potential to prepare individual with job-satisfying requirements towards employment and self-reliance's. An electrical installation and maintenance work graduate of technical colleges should be capable of independent work, but it is observed by Nwaodo (2020) who postulated that the Federal Ministry of Education has observed that some of the factors responsible for the high failure rate of Technical College students in the NABTEB examinations particularly in the electrical installation and maintenance include poor teaching methodology in the Technical Colleges. Eze and Osuyi (2019) revealed in a study carried out in Edo State on electrical installation and maintenance works that teaching and learning facilities are obsolete, inadequate and not digital friendly.

Also, most of electrical installation and maintenance work (EIMW) teachers seem to be using teacher-centered teaching methods probably because they are not familiar with modern teaching method such as problem-based teaching method. Lecture and demonstration method that is commonly used by EIMW teachers over the years seems to have inadequately equipped the students for NTC examination,. Asogwa, (2018) posited that lecture-demonstration method encourages laziness, rote memorization and could eventually kill students' interest, attitude and retention towards the subject. It was not clear to the researcher whether the use of the problem

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solving instructional teaching techniques (inquiry and challenge-based) could improve students' academic achievement and retention in electrical installation and maintenance work in technical colleges, in Niger State, hence this research intend to find out the effect of inquiry and challenge-based instructional teaching techniques on student learning outcomes in electrical installation and maintenance work in technical colleges in Niger State, Nigeria. Specifically, the objectives of the study are to determine the effects of inquiry and challenge-based instructional teaching techniques on students' academic achievement in electrical installation and maintenance work; effect of inquiry and challenge-based instructional teaching techniques on students' retention in electrical installation and maintenance work.

Research Questions

The following research questions guided the study

1. What are effects of inquiry and challenge-based instructional teaching techniques on students' academic achievement in electrical installation and maintenance work?
2. What are the effects of inquiry and challenge-based instructional teaching techniques on students' retention in electrical installation and maintenance work?

Hypotheses

The following null hypotheses was tested at 0.05 level of significance to guides the study

$H0_1$: There is no significant difference in the mean responses of students on inquiry based and challenge-based instructional teaching techniques on academic achievement in electrical installation and maintenance work.

$H0_2$: There is no significant difference in the mean responses of students on inquiry based and challenge-based instructional teaching techniques on students' retention in electrical installation and maintenance work.

Methodology

This study adopted the use of Quasi-experimental design. Specifically, the pre-test –post-test non-equivalent control group design for the study. An intact class was used in order not to disturb the academic programmes of schools involved in the study. The area of this study is Niger State, Nigeria. The targeted population for this study was 181 National Technical Certificate (NTC II)

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students who are taking electrical installation and maintenance work in the seven technical colleges in Niger State. The sample for the study comprised of 61 NTC II electrical installation and maintenance work students from two technical colleges which includes Government Technical College, Minna, and Government technical college Eyagi-Bida, Niger State. The instrument that was used for data collection are Electrical installation and maintenance work Achievement Test (EIWAT). The instruments (lesson plans) were subjected to face and content validation by two experts in Department of Industrial and Technology Education, Federal University of Technology Minna, Niger State and one expert from Government technical college, Minna Niger State. A trial test of the instruments was carried out on 22 randomly selected NTC II students from Government Technical College Jos, Plateau State. Kuder Richardson 21 (K-R21) was used for EIWAT and a coefficient of 0.725 was obtained. The study was conducted during the normal school periods. The usual timetable for the contact periods of the school was followed. The electrical installation and maintenance work teachers in the schools were used as research assistants. They were brief on how to use lesson plans for the training manual. Data collected for the study, was analysed using Statistical Package for Social Science (SPSS). Descriptive and inferential statistics was used to analyse the data. The null hypotheses were tested using Analysis of Covariance (ANCOVA) at a 0.05 level of significance. The group with higher mean value irrespective of the closeness in the mean value of the other was taken to have performed better in academic achievement. If the F calculated is less than 0.05, the null hypotheses was rejected and if the significance of F calculated is greater than 0.05, the null hypotheses was accepted.

Results

Research Question One: What are effects of inquiry and challenge-based instructional teaching techniques on students' academic achievement in electrical installation and maintenance work?
Data collected for research question one is presented in Table 1.

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Table 1: Mean and Standard Deviation of Inquiry and Challenge-Based Instructional Teaching Techniques on Students' Academic Achievement in Electrical installation and maintenance work

		Pretest		Posttest		Mean Gain
Method	**N**	**Mean**	**SD**	**Mean**	**SD**	
Inquiry-based instructional teaching techniques	32	16.21	0.96	25.67	1.81	9.46
Challenge-based instructional teaching techniques	29	16.88	1.09	28.51	2.03	11.63

Table 1 shows the mean and standard deviation of academic achievement of pre-test and post-test score of students taught using inquiry and challenge-based instructional teaching techniques. From the results, it can be deduced that mean and SD scores of the pretest and posttest test scores of inquiry and challenge-based instructional teaching techniques are showed above. The Mean gains were 9.46 and 11.63 respectively. The post-test score shows that Challenge-based instructional teaching techniques have higher mean score of 28.51 than Inquiry-based instructional teaching techniques with mean score of 25.67. The analysis of this result shows that the challenge-based instructional teaching techniques test score is higher than the achievement score of inquiry-based instructional teaching techniques. Therefore challenge-based instructional teaching techniques is more effective than the inquiry-based instructional teaching techniques in enhancing student's achievement in electrical installation and maintenance work.

Research Question Two

What are the effects of inquiry and challenge-based instructional teaching techniques on students' retention in electrical installation and maintenance work?

Data collected for research question two is presented in Table 2.

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Table 2: Mean and Standard Deviation of Inquiry and Challenge-Based Instructional Teaching Techniques on Students' Retention in Electrical installation and maintenance work

		Pretest (a)		Posttest (b)		Delayed Post-test ©		Mean Difference
Method	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**c-b**
Inquiry-based instructional teaching techniques	32	16.21	0.96	25.67	1.81	27.13	1.54	1.46
Challenge-based instructional teaching techniques	29	16.88	1.09	28.51	2.03	30.66	2.47	2.15

Table 2 shows the mean and standard deviation of students retention in pre-test, post-test score and delay post-test of students taught using inquiry and challenge-based instructional teaching techniques. From the results, it can be deduced that mean and SD scores of the post-test and delay post-test scores of inquiry and challenge-based instructional teaching techniques are showed above respectively. The Mean differences were 1.46 and 2.15 respectively. The delayed post-test score shows that challenge-based instructional teaching techniques have higher mean score of 30.66 than inquiry-based instructional teaching techniques with mean score of 28.51. The analysis of this result shows that the challenge based instructional teaching techniques retention achievement test score is higher than the retention achievement score of inquiry-based instructional teaching techniques. Therefore challenge-based instructional teaching technique is more effective than the inquiry-based instructional teaching techniques in enhancing students' retention in electrical installation and maintenance work.

Hypothesis one

There is no significant difference in the mean responses of students on inquiry based and challenge-based instructional teaching techniques on academic achievement in electrical installation and maintenance work.

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Table 3: Analysis of Covariance (ANCOVA) of students on challenge based approaches and inquire based learning techniques on academic achievement on electrical installation and maintenance work.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	202.765[a]	2	101.382	22.621	.001
Intercept	1204.071	1	1204.071	268.658	.001
Pretest	2.320	1	2.320	.518	.473
Method	121.261	1	121.261	26.042	.014
Error	685.716	153	4.482		
Total	75997.000	156			
Corrected Total	888.481	155			

Table 3 revealed the ANCOVA result of students on inquiry based and challenge-based instructional teaching techniques on students' academic achievement in electrical installation and maintenance work. The result indicates that F-ratio= 26.042 with p=0.014 respectively. The p value is less than α value. Therefore, there was a significant difference between the mean academic achievement scores of students taught using inquiry-based instructional teaching techniques and challenge-based instructional teaching techniques on academic achievement in electrical installation and maintenance work. The null hypothesis was rejected. This result revealed that students taught electrical installation and maintenance work with challenge-based teaching approach achieved more than those taught with inquiry-based teaching approach.

Hypothesis Two

There is no significant difference in the mean responses of students on inquiry based and challenge-based instructional teaching techniques on student's retention in electrical installation and maintenance work.

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Table 4: Analysis of Covariance (ANCOVA) of students on inquiry based and challenge-based instructional teaching techniques on students' retention in electrical installation and maintenance work

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	.070[a]	2	.035	1.987	.147
Intercept	29.958	1	29.958	1692.975	.000
Posttest	.052	1	.052	2.963	.091
METHOD	.000	1	.000	.352	.071
Error	.991	56	.018		
Total	697.112	59			
Corrected Total	1.061	58			

Table 4 revealed the ANCOVA result of students on inquiry based and challenge-based instructional teaching techniques on student retention in electrical installation and maintenance work. The result indicates that F-ratio= 0.352 with p=0.071 respectively. The p value is greater than α value. Therefore, there was no significant difference between the mean retention scores of students taught using inquiry based and challenge-based instructional teaching techniques on students' retention in electrical installation and maintenance work. The null hypothesis was accepted. This result revealed that students taught electrical installation and maintenance work with challenge-based instructional teaching techniques have better retention achievement than those taught with inquiry-based instructional teaching techniques.

Discussion

The findings on research question one on the effects of inquiry and challenge-based instructional teaching techniques on students' academic achievement in electrical installation and maintenance work revealed that the challenge-based instructional teaching techniques academic achievement test score is higher than the achievement score of inquiry-based instructional teaching techniques. Therefore challenge-based teaching approach is more effective than the inquiry-based instructional teaching techniques in enhancing students' academic achievement in electrical installation and maintenance work. This finding was in line with the Badde *et al.*, (2023) conducted a research work on the effects of challenge-based and activity – based approaches on students learning outcomes in fabrication and welding craft practices in technical colleges in Kaduna State revealed that challenge-based teaching approach is more effective than the activity-based teaching approach in enhancing students' psychomotor achievement in welding and fabrication. This finding is in agreement with Hassan *et al.*, (2019) who found that students taught woodwork using the

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challenge-based learning instructional approach had a higher mean score than students taught using the activity-based learning teaching method in cognitive achievement test.

The finding on Table 3 hypotheses one revealed that there was a significant difference between the mean academic achievement scores of students taught using inquiry-based instructional teaching techniques and challenge-based instructional teaching techniques on academic achievement in electrical installation and maintenance work. Hassan *et al*. (2019) conducted a research work on effects of challenge-based and activity-based learning approaches on technical college students' achievement and retention in woodwork trade in Zamfara and Katsina. Three research questions and three null, hypotheses were tested at 0.05 level of significances, guided the study. A pre-test, post-test, non-equivalent control group, quasi-experimental research design was adopted. The study revealed that there was a significant different between the mean score of students taught woodwork using the challenge-based learning instructional approach and activity-based learning teaching method in cognitive achievement test. Consequently, the research recommended that the National Board for Technical Education (NBTE) should consider a review of Woodwork work curriculum for Technical Colleges with a view to incorporating the challenge-based learning instructional approach into the teaching of woodwork.

The findings on Table 2 research question two effects of inquiry and challenge-based instructional teaching techniques on students' retention in electrical installation and maintenance work revealed that the challenge based instructional teaching techniques retention achievement test score is higher than the retention achievement score of inquiry-based instructional teaching techniques. Therefore challenge-based instructional teaching techniques is more effective than the inquiry-based instructional teaching techniques in enhancing students' retention in electrical installation and maintenance work. This is in line with Eze *et al.*, (2021) revealed that retention is an important variable in learning especially in technical subjects. This is because achievement lasts only when students are able to retain what they have learnt. A technical student that learns a concept and easily forgets will not perform well in the world outside school. Retention is important in sustenance of achievement. This is because if a student achieved a high score in a post -test but a low score in the retention test, it is an indication that the students did not register the concept in the long-term memory.

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The finding on Table 4 hypotheses two revealed there was no significant difference between the mean retention scores of students taught using inquiry based and challenge-based instructional teaching techniques on retention in electrical installation and maintenance work. The null hypothesis was accepted. This result revealed that students taught electrical installation and maintenance work with challenge-based instructional teaching techniques have better retention achievement than those taught with inquiry-based instructional teaching techniques. However, this finding is at variance with Owoh and Ogwa (2019) who reported a significant difference in the mean retention scores of technical college students taught electrical installation and maintenance works with prior knowledge of instructional objectives and those taught the same topic with prior knowledge of the instructional objectives.

Conclusion

Based on the findings of the study, it was concluded that both inquiry-based and challenge-based instructional teaching techniques are effective for improving students' academic achievement and retention in electrical installation and maintenance work in technical colleges but challenge- based is more effective for enhancing students' academic achievement and retention of technical college students in electrical installation and maintenance work. Therefore, it is concluded that, challenge-based instructional teaching techniques had positive effects on students' academic achievement and retention in electrical installation and maintenance work.

Recommendations

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

1. National Board for Technical Education (NBTE) should consider a review of electrical installation and maintenance work curriculum for Technical Colleges with a view to incorporating the challenge-based instructional teaching techniques into the teaching of electrical installation and maintenance work.
2. Electrical installation and maintenance work teachers should adopt the use of challenge-based instructional teaching techniques to enhance students' academic achievement and retention in electrical installation and maintenance work.

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3. Electrical installation and maintenance work students should also embrace teaching and learning through the use of challenge-based instructional teaching techniques in other to enhance their academic achievement and retention.

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