EFFECT OF CHALLENGE-BASED AND ACTIVITY-BASED INSTRUCTIONAL TECHNIQUES ON MOTOR VEHICLE MECHANICS STUDENTS LEARNING OUTCOMES IN TECHNICAL COLLEGES IN KANO STATE, NIGERIA

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Abstract

The study investigated the effect of challenge-based and activity-based instructional techniques on motor vehicle mechanics students learning outcomes in technical colleges in Kano State. Two research question and two null hypotheses guided the study. A Quasi experimental research design was adopted for the study. The study was conducted on motor vehicle mechanics students from two technical colleges (Government Technical College, Kano and Government Technical College, Ungogo) in Kano State. Purposive sampling technique and simple random sampling technique was adopted for this study. A purposive sampling technique was used to select two technical colleges that offer MVM trade from the six technical colleges. A simple balloting technique also used to assign a school to the experimental group (Challenged-based teaching strategy) and the other school to control group (Activity-based teaching strategy). The total of 65 TC II students from the two technical colleges chooses. The instruments that were used for data collection are Motor Vehicle Mechanics Works Achievement Test (MVMWAT), and MVMW Psychomotor Skills Achievement Test (MVMWPSAT) validated by three experts from Department of Industrial and Technology Education, Federal University of Technology, Minna Niger State. The reliability coefficient of the instrument was determined to be 0.88 through Cronbach Alpha Statistics. Descriptive and inferential statistics was used to analyse the data. The null hypotheses were tested using Analysis of Covariance (ANCOVA) at .05 level of significance. The findings among others revealed that Students taught MVMW with activity-based instructional technique have higher cognitive achievement in mean gain with 26.31 than the challenge-based instructional techniques with mean gain of 22.95, Students taught MVMW with activity-based instructional technique have higher psychomotor skills achievement mean gain with 1.55 than the challenge-based instructional techniques with mean gain of 1.15. Based on the finding it was recommended that the ministry of Education should review the curriculum for MVMW with a view to incorporate activity-based instructional techniques into the teaching and learning of MVMW to improve the cognitive and psychomotor achievement of the students. Technical college teachers should be sensitized on the efficacy of activity-based instructional techniques through conference, seminars and workshops.

Keywords: Technical Colleges, Motor Vehicle Mechanical Works (MVMW), Challenge-Based Instructional Technique, Activity-Based Instructional Technique, Learning Outcomes, Cognitive Achievement and Psychomotor Achievement

Introduction

Technical colleges are post-basic schools that specialize on providing practical hand-on training and education to prepare students for specific careers in industries and other sectors of economy. According to Ubanwa *et. al.* (2022), technical colleges are institutions where students are trained to acquire relevant skills and knowledge in different trade areas in order to become self-reliant or take-up paid jobs as craftsmen and master craftsmen in the world of work. The trade programmes offered in the attainment of these goals in technical colleges

according to FRN (2013) includes; painting and decorating, electrical installation work, blocklaying, bricklaying and concreting, air conditioning and refrigeration, carpentry and joinery, furniture making and upholstery, plumbing work, fabrication and welding craft practice as well as motor vehicle mechanic trades.

Motor Vehicle Mechanic Work (MVMW) is one of the trades offered at technical college level in Nigeria. The trade is designed to equip the learners with employable and profitable skills required to work as professional motor vehicle mechanics in automotive industry. The trade involves hands-on experience with repairing, maintaining, and diagnosing issues in various types of vehicles such as cars, trucks, motorcycles, and other motorized vehicles. The goal of MVMW as contained in the National Board for Technical Education (NBTE, 2001) is to produce skilled craftsmen with quality knowledge of the working principles of motor vehicles, the techniques and safety practices involved in the maintenance and repairs of vehicles. However, the reverse is the case as most auto-mechanic craftsmen produced from Nigerian technical colleges are unable to service and repair faults on motor vehicles (Adamu *et al.*, 2022). Nwolu-Elechi (2013) attributed this poor skill performance among MVMW graduates to the instructional techniques deployed by MVMW teachers to inculcate knowledge and skills to the learners. Some of the commended techniques which MVMW teachers are expected to adopt in order to bring about effective skills acquisition and improve the academic performance of MVMW students include problem-based instructional techniques such as activity-based and challenge-based instructional technique.

Challenge-based instructional technique is one of the innovative pedagogies in the field of education that actively engages students in relevant real-world problem that occur in their environment and that require a remedy. According to Badde *et al.* (2023) challenge-based instructional technique is an immersive, multidisciplinary approach to teaching and learning that allows students to use the technologies they use to solve real-world challenges in their everyday lives. Challenge-based instructional technique in the context of this study is a collaborative learning experience in which MVMW teachers and students work together to learn about compelling issues, propose solutions to real problems relating to motor vehicles, and take action. Another problem based instructional techniques which can solve real-world problem in MVMW trade is activity-based instructional technique.

Activity-based instructional technique is the process of learning by performing tasks. It involves the use of hands-on, experiential activities to facilitate learning. According to Albadi and David (2019), activity-based instructional technique can be regarded as a fruitful learning approach that helps student to grasp the required outcomes defined by the teacher himself. Activity-based instructional techniques in the context of this study is an instructional approach that emphasizes on MVMW students' active learning through various activities to develop the three domains of learning (cognitive, affective, and psychomotor) equally in motor vehicle mechanics trade. The ultimate aim of any instructional approach is for the students to achieve the desired learning outcomes.

Learning outcomes are measurable statements that articulate value as a result of taking a course or completing a programme. According to Badde *et al.* (2023) learning outcomes are behaviors that students can perform after the learning has taken place. Learning outcomes in the context of this study measure the potential applications of knowledge and skills acquired by students in MVMW. Hence, one of the learning outcomes to be covered in this study are students psychomotor and cognitive achievement.

Cognitive achievements refer to the intellectual accomplishments and milestones reached by individuals through the development and application of cognitive abilities such perception, memory, reasoning, problem-solving and decision making. Nwosu *et al.* (2022) explained that cognitive achievement involves the ability of students to apply critical thinking, analytical reasoning and problem-solving strategies to solve complex problems across different subject areas and real-world contexts. Hence students in technical colleges are encouraged to acquire intellectual growth and development beyond the technical aspects of their chosen fields which focuses on psychomotor achievement.

Psychomotor achievement can be regarded as development of organized patterns of muscular activities guided by signals from the environment. Ogbuanya *et al.*, (2021) explained that psychomotor achievement refers to achievement of students in practical task which is usually represented by a score or mark obtained in a performance test. Psychomotor achievement in the context of this study is the coordination of a sensory or ideational (cognitive) process and a motor activity of MVM students in technical colleges. However, there are other studies that showed a significant difference on the effect of challenged-based teaching technique on students' cognitive and psychomotor in woodwork and metalwork technology of education (Badde, *et al.*, 2023; Hassan & Abdullahi, 2020). Based on the variations in the findings by various researchers, the researcher aims to determine the effect of challenge-based and activity-based instructional techniques on motor vehicle mechanics students learning outcomes in technical colleges in Kano State.

Statement of the Research Problem

The motor vehicle craftsmen and master craftsmen are neither employed by relevant industries nor be self-reliant, because of the limited skills acquired which may be as a result of wrong teaching methods used by their teachers and resources provided for the school for teaching. Therefore, there is need for a change of method and technique in the teaching of motor vehicle mechanic works, so as to enable the students of technical college acquire adequate knowledge and skills for the world of work, hence the problem of the study is to find out the effect of challenge-based and activity-based instructional techniques on motor vehicle mechanics students learning outcomes in technical colleges in Kano State.

Objectives of the Study

The objectives of the study are to determine the effect of:

1. Challenge-based and activity-based instructional techniques on students' cognitive achievement in MVMW in technical colleges in Kano State.
2. Challenge-based and activity-based instructional techniques on students' psychomotor skills achievement in MVMW in technical colleges in Kano State.

Research Questions

The following research questions will guide the study

1. What is the effect of challenge-based and activity-based instructional techniques on students' cognitive achievement in MVMW in technical colleges in Kano State?
2. What is the effect of challenge-based and activity-based instructional techniques on students' psychomotor achievement in MVMW in technical colleges in Kano State?

Hypotheses

The following null hypotheses were formulated to guide the study and will be test at 0.05 level of significance.

H_{o1}: There is no significant difference in the mean cognitive achievement scores of students taught MVMW using challenge-based and activity-based instructional techniques in technical colleges in Kano State.

H_{o2}: There is no significant difference in mean psychomotor skills achievement scores of students taught MVMW using challenge-based and activity-based instructional techniques in technical colleges in Kano State.

Methodology

This study adopted a quasi-experimental design. Specifically, the pre-test-post-test non-equivalent control group design. The pre-test post-test non-equivalent group design is a specific type of quasi-experimental design used in research to compare the effects of an intervention or treatment on two or more naturally occurring groups (Smith, 2020). The study was conducted on motor vehicle mechanics students from two technical colleges (Government Technical College, Kano and Government Technical College, Ungogo) in Kano State. Purposive sampling technique and simple random sampling technique was adopted for this study. A purposive sampling technique was used to select two technical colleges that offer MVM trade from the six technical colleges. A simple balloting technique also used to assign a school to the experimental group (Challenged-based teaching strategy) and the other school to control group (Activity-based teaching strategy). The total of 65 TC II students from the two technical colleges chooses. The instruments that were used for data collection are Motor Vehicle Mechanics Works Achievement and Retention Test (MVMWART), MVMW Psychomotor Skills Achievement Test (MVMWPSAT) and Motor Vehicle Mechanics Works Interest Inventory (MVMWII) validated by three experts from Department of Industrial and Technology Education, Federal University of Technology, Minna Niger State. The reliability coefficient of the instrument was determined to be 0.88 through Cronbach Alpha Statistics. Descriptive and inferential statistics was used to analyse the data. The null hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. If the significant of 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 is the effect of challenge-based and activity-based instructional techniques on students' cognitive achievement in MVMW in technical colleges in Kano State?

The data for answering Research Question 1 is presented in table 1

Table 1: Mean of Pre-test and Post-test Cognitive Achievement Scores of Students taught MVMW using Challenge-Based and Activity-Based Instructional techniques.

		Pre-test		Post-test		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Challenge-Based Instructional Technique	23	15.96	6.15	38.91	6.73	22.95
Activity-Based Instructional Technique	42	11.69	5.37	38.00	8.91	26.31

Table 1 shows that, the experimental group I taught with challenge-based instructional techniques had pre-test mean achievement score of 15.96 with standard deviation of 6.15 and post-test score of 38.91 with standard deviation of 6.73. The mean gained between the pre-test and post-test of the experimental group I was 22.95. The experimental group II taught with activity-based instructional techniques had pre-test mean achievement score of 11.69 with

standard deviation of 5.37 and post-test score of 38.00 with standard deviation of 8.91. The mean gained between the pre-test and post-test of the experimental group II was 26.31. The experimental group II had higher mean gained than experimental group I.

Research Question Two

What is the effect of challenge-based and activity-based instructional techniques on students' psychomotor achievement in MVMW in technical colleges in Kano State?

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

Table 2: Mean and Standard Deviation of Challenge-Based and Activity-Based Instructional Techniques on Students' Psychomotor Achievement in MVMW

		Pre-test		Post-test		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Challenge-Based Instructional Technique	23	1.78	0.10	2.93	0.16	1.15
Activity-Based Instructional Technique	42	2.22	0.07	3.77	0.23	1.55

Table 2 shows the mean and standard deviation of psychomotor skills achievement pre-test and post-test score of students taught using challenge and activity-based instructional techniques. From the results, it can be deduced that mean and SD scores of the pretest and posttest scores of challenge and activity-based instructional techniques are X=1.78, SD=0.10, X=2.93, SD =0.16 and X=2.22, SD=0.07, X=3.77, SD= 0.23 respectively. The Mean gains were 1.15 and 1.55 respectively. The post-test score shows that activity-based instructional techniques have higher mean score of 1.55 than challenge-based instructional techniques with mean score of 1.15. The analysis of this result shows that the activity-based instructional techniques for psychomotor skills achievement test score is higher than the psychomotor skills achievement score of challenge-based teaching approach. Therefore activity-based instructional technique is more effective than the challenge-based instructional techniques in enhancing students psychomotor skills achievement in MVM.

Hypothesis One

There is no significant difference in the mean cognitive achievement scores of students taught MVMW using challenge-based and activity-based instructional techniques in technical colleges in Kano State.

To test this formulated hypothesis, Analysis of Covariance (ANCOVA) was employed, and the result was presented in Table 3.

Table 3: Analysis of Covariance (ANCOVA) of students on challenge-based and activity-based instructional techniques on cognitive achievement in MVMW

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	99.856[a]	2	49.928	.742	.480
Intercept	11340.527	1	11340.527	168.598	.000
Pretest	87.467	1	87.467	1.300	.259
Instructional Techniques	.008	1	.008	.000	.991
Error	4170.359	62	67.264		
Total	99733.000	65			

Corrected Total	4270.215	64

Dependent Variable: posttest a. R Squared = .023 (Adjusted R Squared = -.008)

Table 3 show the F-calculated value for testing the significance difference between the cognitive achievement scores of students taught MVMW using challenge-based instructional techniques and those taught with activity-based instructional techniques. The F calculated value of 0.000 was obtained with associated exact probability value of .991. Since the associated probability of 0.991 was greater than 0.05 at a level of significance, the null hypothesis which stated that there is no significant difference in the mean cognitive achievement scores of students taught MVMW using challenge-based and activity-based instructional techniques was accepted. Hence, there was no significance difference between the mean achievement scores of students taught MVMW using challenge-based and those taught with activity-based instructional techniques. This result revealed that students taught MVMW with challenge-based instructional techniques have lower cognitive achievement than those taught with activity-based instructional techniques.

Hypothesis Two

There is no significant difference in mean psychomotor skills achievement scores of students taught MVMW using challenge-based and activity-based instructional techniques in technical colleges in Kano State.

To test this formulated hypothesis, Analysis of Covariance (ANCOVA) was employed, and the result was presented in Table 4.

Table 4: Analysis of Covariance (ANCOVA)of students on challenge-based and activity-based instructional techniques on psychomotor skills achievement in MVM

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	11.493[a]	2	5.746	213.835	.000
Intercept	.002	1	.002	.069	.794
MEANPRETEST	1.077	1	1.077	40.070	.000
INSTRUCTIONALTECHNIQUES	.030	1	.030	1.135	.291
Error	1.666	62	.027		
Total	798.719	65			
Corrected Total	13.159	64			

Dependent Variable: MEANPOSTTEST a. R Squared = .873 (Adjusted R Squared = .869)

Table 4 revealed the ANCOVA result of students on challenge-based and activity-based instructional techniques on psychomotor skills achievement in MVMW. The result indicates that F-ratio= 1.135 with p=0.291 respectively. The p value is greater than α value. Therefore, there was no significant difference between the mean psychomotor skills achievement scores of students taught using challenge-based and activity-based instructional techniques on psychomotor achievement in MVMW. The null hypothesis was accepted. This result revealed that students taught MVMW with activity-based instructional techniques have better psychomotor skills achievement than those taught with challenge-based instructional techniques

Discussion of Findings

The findings on research question one on the effects of challenge-based and activity-based instructional techniques on students' cognitive achievement in MVMW revealed that students taught MVMW with activity-based instructional technique have higher cognitive achievement test score than the challenge-based instructional technique. Therefore activity-based instructional technique is more effective than the challenge-based instructional technique in enhancing students' cognitive achievement in MVMW. The findings contrast with Badde *et al.* (2023) who studied effects of challenge-based and activity-based approaches on students learning outcomes in fabrication and welding craft practices in technical colleges in Kaduna State. The study revealed that challenge-based teaching approach is more effective than the activity-based teaching approach in enhancing student's achievement in welding and fabrication. The finding of the study is incongruity to Ogbuanya, *et al.* (2021) who studied effects of challenge-based and activity-based learning approaches on technical college students' achievement, interest and retention in woodwork technology. The study revealed that students taught woodwork using the challenge-based learning instructional approach had a higher mean score than students taught using the activity-based learning teaching method in cognitive achievement tests.

The findings on hypothesis one, there is no significant difference in the mean cognitive achievement scores of students taught MVMW using challenge-based and activity-based instructional techniques. There was no significance difference between the mean cognitive achievement scores of students taught MVMW using challenge-based and those taught with activity-based instructional techniques. The null hypothesis was accepted. The finding is also in support of Khan *et al.* (2017) conducted a research work on the impact of activity-based teaching on students' achievement in Physics at secondary level. The study revealed that there was a positive impact of activity-based teaching in developing cognitive skills in the students of physics at secondary level. Consequently, the research recommended that the National Board for Technical Education (NBTE) should consider a review of MVMW work curriculum for Technical Colleges with a view to incorporating the activity-based instructional techniques into the teaching of MVMW.

The findings on research question two on the effects of challenge-based and activity-based instructional techniques on students' psychomotor skills achievement in MVMW revealed that the students taught MVMW with activity-based instructional technique have higher psychomotor skills achievement test score than the challenge-based instructional techniques. Therefore activity-based instructional technique is more effective than the challenge-based instructional technique in enhancing students' psychomotor achievement in MVMW. The findings incongruity with Badde *et al.* (2023) who studied effects of challenge-based and activity-based approaches on students learning outcomes in fabrication and welding craft practices in technical colleges in Kaduna State. The study revealed that students taught welding and fabrication with challenge-based teaching approach have higher psychomotor achievement test score than the activity-based teaching approach. Therefore, challenge-based teaching approach is more effective than the activity-based teaching approach in enhancing student's psychomotor achievement in welding and fabrication. The finding is discrepancy with Hassan & Abdullahi (2020) who carried out research on effect of activity-based and challenge-based learning approaches on technical colleges students' psychomotor achievement in furniture craft technology in Zamfara and Katsina State and found out that the challenge-based learning approach is more successful in enhancing the students' psychomotor achievement in furniture craft technology than the activity-based learning approach. Consequently, the research recommended that the National Board for Technical Education (NBTE) should consider a

review of MVMW work curriculum for Technical Colleges with a view to incorporating student-centered instructional techniques into the teaching of MVMW.

The findings on hypothesis two, there is no significant difference in mean psychomotor skills achievement scores of students taught MVMW using challenge-based and activity-based instructional techniques. It revealed that there was no significance difference between the mean psychomotor achievement scores of students taught MVMW using challenge-based and those taught with activity-based instructional techniques. The findings of the study dissension with Badde *et al.* (2023) who revealed that there was a significant difference between the mean psychomotor achievement scores of students taught using challenge-based approach and those taught using activity-based learning approach in welding and fabrication. Consequently, the research recommended that the Government and private technical colleges should employ teachers who know the MVMW content and have the pedagogical skills to apply student-centered teaching methods like the activity-based instructional technique.

Conclusion

The study identified the effect of challenge-based and activity-based instructional techniques on motor vehicle mechanics students learning outcomes in technical colleges in Kano State. The study revealed that activity-based instructional technique is more effective than the challenge-based instructional technique in enhancing students' cognitive and psychomotor achievement in MVMW. The use of activity-based instructional technique is fruitful learning approach that helps student to grasp the required outcomes defined by the teacher himself.

Recommendations

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

1. The ministry of Education should review the curriculum for MVMW with a view to incorporate activity-based instructional techniques into the teaching and learning of MVMW to improve the cognitive and psychomotor achievement of the students.
2. Technical college teachers should be sensitized on the efficacy of activity-based instructional techniques through conference, seminars and workshops.

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