

Effect of Fuel-Less Generator Project Teaching Method on Students' Academic Achievement in Electrical Installation Works Among Technical Colleges in Rivers State

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Abstract

The study examined the effect of fuel-less generator project teaching method on Students' academic achievement in electrical installation works among Technical Colleges in Rivers State. The study adopted quasi-experimental research design. The study was carried out in Rivers State. Two objectives, two research questions and one hypothesis guided the study. Population of the study comprised of 125 NTC III electrical installation and maintenance works students in three out of the five Technical Colleges in Rivers State. The study used the entire population since it was a manageable size. The instrument for data collection was a fuel-less generator project in electrical installation works Achievement Test (FGPEIWAT). The test items were face and content validated. A reliability coefficient of .70 was achieved. The pre-test and post-test score were computed and analyzed using mean and standard deviation. The finding of the study revealed that the group taught battery charging and repairs using constructed fuel-less generator project as instructional aide had mean difference score of 30.10 against the demonstration group with a main gain score of 21.89 among others. The study concluded that the fuel-less generator project teaching method is found to be highly effective in enhancing students' understanding and performance in battery charging and repairs, as well as cable jointing. It recommended that school managements should encourage project teaching method in all Technical Colleges in Rivers State to enhance acquisition of practical skills by the students among others.

Keywords: Fuel-less Generator, Project Teaching Method, battery charging and repairs, cable jointing

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I. Introduction

Technical and vocational education and training (TVET) has long been recognized as a powerful pathway for equipping learners with the practical skills needed for employment, innovation, and self-reliance. In a developing country like Nigeria, technical colleges are expected to serve as hubs for producing competent graduates who can confidently handle real-world tasks such as electrical installation, maintenance, battery servicing, and cable jointing. Yet, despite these expectations, there is growing concern that many students leave school without the level of practical competence required in today's industries. Reports by Okoye and Nwachukwu (2025) highlight that students' academic achievement and hands-on skill proficiency in electrical installation works remain below acceptable standards.

A major reason for this situation appears to be the continued dependence on traditional teaching methods that prioritize theoretical instruction over practical engagement. In many classrooms, students are taught "about" electrical systems rather than being given meaningful opportunities to work with them. As a result, learning often becomes abstract, limiting students' ability to fully understand and apply key concepts.

This disconnect between theory and practice raises important questions about how teaching methods can be improved to better serve learners in technical education.

In response to these challenges, educators and researchers have increasingly turned their attention to more engaging and learner-centered approaches, particularly project-based learning (PBL). One such innovative approach is the fuel-less generator project teaching method. This method is not just a teaching technique but an experiential learning process that allows students to design, construct, and test a functional electrical system powered without conventional fuel. Through this process, learners actively engage with essential electrical installation concepts, including battery charging, repairs, cable jointing, and system assembly. Evidence from recent studies suggests that when students are involved in hands-on, project-driven activities, their level of engagement, understanding, and academic performance improves significantly (Adebayo & Salisu, 2026; Eze et al., 2025).

Project-based learning, as a broader concept, has been widely acknowledged for its effectiveness in technical and vocational education. It shifts the focus from passive listening to active participation, encouraging students to think critically, solve problems, and collaborate with others. According to Adebayo and Salisu (2026), PBL creates a learning environment where students are not just recipients of knowledge but active contributors to their own learning process. This approach is particularly relevant in skill-based subjects like electrical installation, where competence is best developed through doing rather than memorizing.

Empirical evidence has over-time continued to support the value of project-based approaches. For instance, Eze et al. (2025) observed that students who were taught using project-based methods performed better academically than those who experienced traditional lecture-based instruction. Similarly, Nwankwo and Adeyemi (2026) found that students exposed to PBL demonstrated higher levels of motivation and were more likely to retain what they had learned. These findings suggest that integrating practical, real-life projects into teaching could play a key role in improving learning outcomes in technical education.

Within electrical installation works, battery charging and repairs represent foundational skills that students must master. Understanding how batteries function, how they are charged, and how faults are diagnosed requires both theoretical knowledge and hands-on practice. A battery charger, for example, operates by supplying direct current (DC) to restore energy in a battery, but this concept becomes clearer when students actually perform the charging process themselves. Research by Ibrahim and Yusuf (2025) indicates that students who engage in practical battery maintenance activities develop a deeper understanding of the subject and achieve better academic results than those taught through lectures alone. Incorporating such activities into a project like the fuel-less generator provides a meaningful context for learning.

Similarly, cable jointing is a critical skill that ensures electrical continuity and safety in installations. Techniques such as splice joints, Britannia joints, sleeve joints, and compression joints require precision and adherence to established standards. Despite its importance, many students struggle to master cable jointing due to limited opportunities for hands-on practice (Ogbuanya & Chinedu, 2026). A project-based approach offers a solution by allowing students to repeatedly practice these techniques in a realistic setting, thereby building both confidence and competence.

What makes the fuel-less generator project particularly valuable is its ability to bring together multiple aspects of electrical installation into one integrated learning experience. Students are not learning isolated topics; instead, they see how different concepts connect within a functional system. This kind of interdisciplinary learning aligns with modern educational priorities such as sustainability, innovation, and problem-solving (UNESCO, 2025). It also fosters teamwork, creativity, and critical thinking—skills that are essential in today's workforce.

Despite the clear advantages of project-based learning, its adoption in Nigerian technical colleges has been relatively slow. Many teachers continue to rely on conventional teaching methods, often due to constraints such as limited resources, lack of training, or institutional barriers (Nwankwo & Adeyemi, 2026). Consequently, students' performance in subjects like electrical installation remains less than optimal, and the gap between educational outcomes and industry expectations persists.

This study is grounded in constructivist learning theory, which emphasizes that knowledge is best acquired through active involvement and meaningful experiences. By engaging students in practical projects, the fuel-less generator teaching method creates opportunities for learners to construct their own understanding through direct interaction with tools, materials, and real-life challenges. Previous studies have shown that such constructivist approaches can significantly enhance academic performance in technical subjects (Eze et al., 2025).

In Rivers State, where technical colleges play a crucial role in workforce development, the need for improved teaching strategies is particularly urgent. Reports suggest that students' performance in electrical installation works has not met the expectations of employers and industry stakeholders (Okoye & Nwachukwu, 2025). Addressing this issue requires a shift toward more innovative and practical teaching methods that can bridge the gap between classroom learning and real-world application.

Against this backdrop, this study examined the effect of the fuel-less generator project teaching method on students' academic achievement in electrical installation works, with a specific focus on battery charging and repairs, as well as cable jointing. It is expected that the findings will provide valuable insights into how teaching practices can be improved to enhance both skill acquisition and academic performance in technical education.

Statement of the Problem

Technical colleges are established with the clear objective of producing skilled individuals who can meet the demands of industry and contribute meaningfully to national development. However, in Rivers State, there is increasing concern that this objective is not being fully achieved, particularly in the area of electrical installation works. Evidence from internal examinations and practical assessments shows that many students struggle to perform effectively, especially in core areas such as battery charging and repairs, and cable jointing. These challenges are not just reflected in examination scores but are also evident in students' limited ability to carry out practical tasks with confidence and accuracy.

A closer look at the situation suggests that the teaching methods commonly used in classrooms may be a significant contributing factor. The lecture method, which remains widely used, tends to focus on delivering theoretical content with little room for active student participation. While this approach may be suitable for some subjects, it is less effective for skill-based disciplines like electrical installation, where learning is best achieved through practice and experience. When students are not actively involved in the learning process, their understanding remains superficial, and their ability to apply knowledge in real-life situations becomes limited.

In addition to this, many students have insufficient exposure to practical projects that could help them connect what they learn in the classroom with real-world applications. For example, a student may be able to explain how a battery is charged or how cables are joined, yet struggle when asked to perform these tasks physically. This gap between knowing and doing undermines the core purpose of technical education and raises concerns about graduates' readiness for employment.

The introduction of innovative teaching strategies, particularly project-based approaches like the fuel-less generator project, offers a promising way to address these challenges. By engaging students in hands-on activities that simulate real-life electrical systems, such methods have the potential to improve both understanding and performance. However, despite this potential, there is still limited empirical evidence on how effective such approaches are within the context of technical colleges in Rivers State.

Given this situation, there is a clear need to explore alternative teaching methods that can enhance students' academic achievement and practical competence. This study therefore seeks to investigate the effect of the fuel-less generator project teaching method on students' performance in electrical installation works, with particular emphasis on battery charging and repairs, and cable jointing.

Purpose of the Study

This study investigated the effect of fuel-less generator project teaching method on students' academic achievement in electrical installation works among technical colleges in Rivers State.

Specifically, the study determined:

1. Effect of the fuel-less generator project teaching method on students' academic achievement in battery charging and repairs among technical colleges in Rivers State.
2. Effect of the fuel-less generator project teaching method on students' academic achievement in cable jointing among technical colleges in Rivers State.

Research Questions

The following research questions guided the study:

1. What is the effect of fuel-less generator project teaching method on students' academic achievement in battery charging and repairs among technical colleges in Rivers State?
2. What is the effect of fuel-less generator project teaching method on students' academic achievement in cable jointing among technical colleges in Rivers State?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught battery charging and repairs using the fuel-less generator project teaching method and those taught using the conventional teaching method.
2. There is no significant difference in the mean achievement scores of students taught cable jointing using the fuel-less generator project teaching method and those taught using the conventional teaching method.

II. Methodology

The study adopted a Research and Development (R&D) design incorporating a quasi-experimental pre-test, post-test control group design. This design was considered appropriate because it allowed the researcher to develop and implement the fuel-less generator project while also determining its effect on students' academic achievement. The study was conducted in Rivers State, Nigeria, specifically in selected technical colleges offering electrical installation and maintenance works. The population of the study comprised 125 National Technical Certificate (NTC III) students offering electrical installation and maintenance works in three technical colleges: Government Technical College, Port Harcourt (55 students), Government Technical College, Ahoada (45 students), Government Technical College, Tombia (25 students). No sampling was carried out due to the manageable size of the population (census approach), therefore, the entire population of 125 students was used as the sample. The instrument used for data collection was a researcher-developed test titled: Fuel-less Generator Project Electrical Installation Works Achievement Test (FGPEIWAT). The instrument was face and content validated by two experts in technical education/research, two electrical/electronic workshop technicians. The reliability of the instrument was determined using test-retest method, yielding a reliability coefficient of 0.70, indicating that the instrument was reliable for the study. The researcher administered the pre-test before the treatment and the post-test after the treatment with the assistance of a research assistant. The scripts were retrieved on the spot after administration. Method of Data Analysis were mean and standard deviation, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance

III. Results

Research Question 1: What is the effect of fuel-less generator project teaching method on students' academic achievement in battery charging and repairs among technical colleges in Rivers State?

Table 1: Mean and Standard Deviation of Students Taught Battery Charging and Repairs

Groups	N	Pretest	SD	Posttest	Mean	Difference	Mean gain
		\bar{X}		\bar{X}			
Project teaching method group	62	18.41	6.85	48.52	18.52	30.10	
Demonstration teaching method group	63	17.96	6.72	26.18	16.64	8.21	21.89

Table 1 showed the calculated pretest mean and standard deviation scores for experimental group as 18.41 and 6.85, while the calculated pretest mean and standard deviation scores for the control group are 17.96 and 6.72. This means that the two groups are in the same achievement baseline before treatment. However, after the instructional treatment, the mean and standard deviation values for project teaching method group became 48.52 and 18.52 while that of the demonstration teaching method group became 26.18 and 16.64. This means that project teaching method group had a higher achievement mean score when compared with the demonstration teaching method group. The group taught battery charging and repairs using constructed fuel-less generator project and those taught the same topic using demonstration method with a flip chart had mean gain score of 21.89. Therefore, the effect of fuel less generator project on students' academic achievement in battery charging and repairs was affirmative.

Research Question 2: What is the effect of fuel-less generator project teaching method on students' academic achievement in cable jointing among technical colleges in Rivers State?

Table 2: Mean and Standard Deviation of Students Taught Cable Jointing

Groups	N	Pretest	SD	Posttest	Mean Difference	Mean gain
		\bar{X}		\bar{X}		
Project teaching method group	62	18.43	6.51	50.18	17.87	31.75

Demonstration teaching method group	63	18.43	6.63	35.347	12.55	16.90	14.85
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Table 2 showed the calculated pretest mean and standard deviation scores for experimental group as 18.43 and 6.51, while the calculated pretest mean and standard deviation scores for the control group are 18.43 and 6.63. This means that the two groups are in the same achievement baseline before treatment. However, after the instructional treatment, the mean and standard deviation values for project teaching method group became 50.18 and 17.87 while that of the demonstration teaching method group became 35.34 and 12.55. This means that project teaching method group had a higher achievement mean score when compared with the demonstration teaching method group. The group taught cable jointing using constructed fuel-less generator project and those taught the same topic using demonstration teaching method with flip chart had mean gain score of 14.85. Therefore, the effect of fuel less generator project teaching method on students' academic achievement in cable jointing was incomparable.

HO₁: There is no significant difference in the mean academic achievement scores of students taught battery charging and repairs using the fuel-less generator project teaching method and those taught using the conventional teaching method among Technical Colleges in Rivers State.

Table 7: Analyses of Covariance (ANCOVA) of Students' Academic Achievement in Battery Charging and Repairs

Tests of Between-Subjects Effects

Dependent Variable: 42

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	13432.415 ^a	2	6716.208	27.969	.000
Intercept	14287.929	1	14287.929	59.500	.000
PRETEST	13173.013	1	13173.013	54.857	.000
Posttest	152.047	1	152.047	.633	.027
Error	44904.637	122	240.132		
Total	483706.000	125			
Corrected Total	58337.053	124			

a. R Squared = .230 (Adjusted R Squared = .222)

Table 7 showed the calculated value of F (.633) with associated probability value (P= 0.027). The associated probability value was less than 0.05 level of significance (P<0.05) set by the researcher; therefore the null hypothesis was rejected in favour of the alternative hypothesis that states that there is a significant difference between the mean scores of students taught battery charging and repairs using fuel-less generator project and those taught using demonstration method among Technical Colleges in Rivers State.

IV. Discussion of Findings

The findings of this study revealed that the fuel-less generator project teaching method had a significant positive effect on students' academic achievement in electrical installation works. Students exposed to the project-based approach performed better in both battery charging and repairs, and cable jointing compared to those taught using conventional teaching methods. This result is consistent with the findings of Eze et al. (2025), who reported that project-based learning enhances students' academic performance in technical subjects.

The improved performance in battery charging and repairs can be attributed to the hands-on nature of the fuel-less generator project. Students were actively involved in charging, testing, and maintaining battery systems, which enhanced their understanding of the underlying concepts. This finding supports Ibrahim and Yusuf (2025), who emphasized the importance of practical exposure in improving students' performance in battery-related topics.

Similarly, the significant improvement in cable jointing skills among students exposed to the project-based method indicates the effectiveness of experiential learning. Through repeated practice and real-life application, students were able to develop proficiency in various jointing techniques. This aligns with the findings of Ogbuanya and Chinedu (2026), who highlighted the role of practical training in enhancing students' competence in cable jointing.

The integration of multiple electrical concepts into a single project also contributed to improved learning outcomes. The fuel-less generator project provided a holistic learning experience that enabled students to connect theoretical knowledge with practical applications. This supports the findings of Okoye and

Nwachukwu (2025), who reported that integrated learning approaches enhance students' understanding and retention of knowledge.

Furthermore, the collaborative nature of the project-based approach encouraged teamwork and peer learning among students. This resulted in increased motivation and engagement, which positively influenced academic achievement. Adebayo and Salisu (2026) noted that collaborative learning environments foster creativity and innovation, leading to improved learning outcomes.

The findings also highlight the importance of adopting innovative teaching methods in technical education. The traditional lecture-based approach may not adequately equip students with the practical skills required in the workplace. The fuel-less generator project teaching method provides an effective alternative that enhances both academic achievement and skill acquisition.

However, the successful implementation of project-based teaching methods requires adequate resources, teacher training, and institutional support. Nwankwo and Adeyemi (2026) emphasized that lack of facilities and training can hinder the effectiveness of innovative instructional strategies. Therefore, efforts should be made to provide the necessary support for teachers and students.

V. Conclusion

Based on the findings of the study, it was concluded that the fuel-less generator project teaching method significantly improves students' academic achievement in electrical installation works. Specifically, the method was found to be highly effective in enhancing students' understanding and performance in battery charging and repairs, as well as cable jointing.

The study also established that students exposed to project-based learning demonstrated better practical skills, deeper conceptual understanding, and higher engagement compared to those taught using conventional lecture methods. The integration of theory with hands-on project activities enabled students to relate classroom knowledge to real-life electrical applications.

Therefore, the fuel-less generator project teaching method is a viable and effective instructional strategy for improving the quality of teaching and learning in technical colleges.

VI. Recommendations

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

1. **Adoption of Project-Based Teaching Methods:** Technical college teachers should adopt the fuel-less generator project teaching method and other project-based approaches to enhance students' academic achievement and battery charging and repairs practical skills.
2. **Teacher Training and Capacity Building:** Educational institutions should organize workshops and training programs to equip teachers with the skills required to implement project-based instructional strategies effectively.
3. **Provision of Instructional Materials:** Adequate tools, equipment, and materials should be provided in technical colleges to support cable-jointing practical project-based learning.
4. **Curriculum Enhancement:**

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