EFFECT OF INTEGRATION OF MODERN INDUSTRIAL EQUIPMENT AND SKILL BASED CURRICULUM ON STUDENTS' PERFORMANCE IN ELECTRICAL INSTRUMENTATION AMONG STUDENTS OF TECHNICAL COLLEGES IN SOUTH EASTERN NIGERIA

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Abstract

This study investigated the effect of integrating modern industrial equipment and a skill-based curriculum on students' performance in electrical instrumentation among technical college students in South Eastern Nigeria. The drive of the study is the challenges of inadequate training facilities, outdated equipment, and misalignment of curriculum with current industrial demands. A quasi-experimental research design was adopted. A population of 260 NTC II students was used while a sample of 80 students selected using multistage sampling from four technical colleges in Enugu and Anambra States. Data were collected using an Electrical Instrumentation Performance Test (EIPT), with a reliability coefficient of 0.82. The experimental group was exposed to modern industrial equipment (digital oscilloscope and digital multimeter) alongside skill-based teaching strategies (demonstration and project-based learning), while the control group was taught using conventional methods. Data were analyzed using mean and standard deviation for research questions and ANCOVA for hypotheses testing at 0.05 level of significance. Findings revealed that the use of digital oscilloscope, digital multimeter, demonstration method, and project-based learning significantly improved students' performance in electrical instrumentation. The experimental group outperformed the control group in post-test scores, with all null hypotheses rejected. The study concluded that integrating modern industrial equipment with skill-based instructional approaches enhances students' overall academic performance. The study recommended the provision of modern equipment in technical colleges, adoption of skill-based teaching methods, and continuous curriculum updates to align with industrial needs. These measures are essential for improving technical education outcomes and producing competent graduates for the labour market.

Keywords*:* Modern Industrial Equipment, Skill-Based Curriculum, Students' Performance and Electrical Instrumentation

Introduction

Technical education plays an important role in preparing young people with the practical skills required for employment, self-reliance, and national development. In many developing countries, including Nigeria, technical colleges were established to provide students with occupational skills in various trades such as electrical installation, electronics, and instrumentation. These institutions focus on practical training that enables students to apply scientific and technological knowledge to solve real-life problems in industries and communities. Technical education therefore goes beyond theoretical instruction by

emphasizing practical activities, experimentation, and the use of machines and tools in workshop environments. The goal is to produce skilled technicians who can operate, maintain, and troubleshoot industrial equipment effectively. When technical education functions properly, it contributes significantly to economic growth by supplying competent manpower to the industrial sector (Akinduro, 2026). However, the effectiveness of technical education largely depends on the quality of equipment used for training and the relevance of the curriculum guiding instruction.

The need for modern technical education has become more important as industries across the world continue to adopt advanced technologies and automated systems. Industrial environments today rely heavily on modern equipment such as programmable logic controllers, digital measuring instruments, sensors, and automated control systems. These technologies require workers who possess practical skills in electrical instrumentation and related fields. Electrical instrumentation involves the measurement, monitoring, and control of electrical and industrial processes using specialized instruments and devices. It is a crucial area in industries such as manufacturing, power generation, oil and gas, and telecommunications. For students in technical colleges to become competent in this field, they must be exposed to modern industrial equipment during training. Learning with appropriate training equipment allows students to develop essential technical abilities such as circuit installation, measurement of electrical parameters, and fault detection, which are necessary for professional practice (Edibon, 2024).

Closely related to the use of modern equipment is the concept of a skill-based curriculum. A skill-based curriculum focuses on practical competencies rather than mere theoretical knowledge. In technical education, this type of curriculum ensures that students learn by doing, practicing, and solving real-world technical problems. Instead of memorizing concepts, learners are encouraged to participate actively in laboratory experiments, workshop practices, and project-based activities. Through such practical experiences, students acquire hands-on skills that can be directly applied in industry or entrepreneurship. Studies on technical education have shown that competency-based and skill-oriented training improves learners' practical abilities and prepares them better for employment opportunities (Zhang, 2024). Therefore, integrating a skill-based curriculum with modern industrial equipment could significantly improve the effectiveness of technical training.

Despite the recognized importance of practical training, many technical colleges in Nigeria still face serious challenges related to inadequate facilities and outdated equipment. In several institutions, workshop tools and machines are either insufficient, obsolete, or poorly

maintained. When modern equipment is lacking, students are forced to learn theoretical concepts without the opportunity to practice them effectively. This situation limits their ability to develop technical competence and reduces their confidence in performing industrial tasks. Research on technical colleges has shown that the availability and functionality of workshop equipment significantly influence students learning outcomes and skill acquisition. Where equipment is inadequate, practical training becomes ineffective, thereby affecting students overall academic performance (Kelubi & Odu, 2024).

Another issue affecting technical education is the growing misalignment between the curriculum used in schools and the skills required in modern industries. In today's rapidly changing technological environment, industries are increasingly adopting advanced tools, automation systems, and digital processes that demand workers with up-to-date technical knowledge and strong practical competencies. Employers now seek graduates who are not only theoretically sound but also capable of operating modern equipment, solving real-world technical problems, and adapting to new technological trends (Research and Scientific Innovation [RSI] International, 2025). However, when school curricula are not regularly reviewed and updated to reflect these industrial realities, a significant gap emerges between what is taught in classrooms and what is required in the workplace. This mismatch often results in graduates who possess outdated knowledge and limited practical exposure, making it difficult for them to meet employer expectations or function effectively in modern industrial settings. Consequently, many technical college graduates struggle with employability, productivity, and confidence in carrying out industry-related tasks. In addition, an outdated curriculum tends to emphasize theoretical instruction at the expense of hands-on learning, thereby weakening students' ability to apply knowledge in practical situations.

Recent studies such as that in Research and Scientific Innovation [RSI] International (2025), have therefore emphasized the urgent need to review, restructure, and modernize electrical and electronics technology curricula in Nigeria to align with current labour market demands and technological advancements. Such curriculum improvements should incorporate emerging technologies, industry-relevant skills, and competency-based approaches that promote innovation, problem-solving, and entrepreneurship among learners. This will not only enhance students' employability but also support self-employment and job creation among graduates (RSI International, 2025). Furthermore, aligning the curriculum with industry needs requires collaboration between educational institutions, industry stakeholders, and policymakers to ensure that training content remains relevant and responsive to technological changes. Without such alignment, even the availability of modern industrial equipment in

schools may not yield the desired improvement in students' learning outcomes, as the instructional content guiding their use would remain outdated and ineffective. When there is this alignment of the curriculum with the industry needs, the students' performance will be improved

Students' performance therefore refers to the level of achievement demonstrated by learners in both theoretical knowledge and practical skills during the learning process. In technical education, performance is not only measured by written examinations but also by the ability to perform practical tasks accurately and safely in workshops and laboratories. High student performance indicates that learners have successfully understood concepts and can apply them to solve technical problems. Research in electrical installation training has shown that students who receive practical training with proper instructional facilities perform better academically and retain knowledge longer than those taught without adequate workshop resources (Mohammed, 2021).

Furthermore, practical training is particularly important in the study of electrical instrumentation because the field involves the operation and maintenance of measuring and control devices used in industrial systems. These devices include voltmeters, ammeters, oscilloscopes, sensors, multimeters and control units, which help engineers and technicians monitor and regulate electrical processes. In technical colleges, students studying electrical instrumentation are expected to develop the ability to install, calibrate, and troubleshoot these instruments. Such competencies cannot be achieved through theoretical teaching alone. Instead, students must engage in hands-on activities using real or simulated industrial equipment in a well-equipped laboratory or workshop environment. Practical exposure helps learners develop problem-solving abilities, confidence, and technical creativity necessary for industrial work (Osagiede, 2024).

Considering the importance of practical training, the integration of modern industrial equipment into technical education becomes a critical strategy for improving students learning outcomes. When students interact directly with contemporary machines and instruments, they gain realistic experience similar to what they will encounter in industry. This approach also increases students' interest and motivation to learn because they can see the real-world applications of what they are studying. Additionally, integrating modern equipment with a skill-based curriculum encourages project-based learning, experimentation, and innovation among students. Such learning environments promote deeper understanding of electrical instrumentation and help students develop competencies that are relevant in modern

technological industries. In addition to equipment integration, teaching strategies also play a crucial role in enhancing technical skills among students.

Approaches such as work-based learning, project-based learning, and laboratory experimentation have been shown to improve technical competence among students of electrical installation and related fields. Studies investigating work-based learning in technical colleges found that students who participated in practical industrial training demonstrated higher levels of technical competence compared to those who relied solely on classroom instruction (Ekpo & Bassey, 2024). These findings suggest that combining practical exposure with appropriate equipment and curriculum can significantly enhance students' performance in technical subjects.

The South Eastern region of Nigeria hosts several technical colleges that train students in electrical installation, electronics, and instrumentation trades. These institutions are expected to produce skilled technicians capable of supporting industrial growth in the region. However, concerns have been raised about the declining performance of students in technical trades due to inadequate facilities, outdated curriculum structures, and insufficient exposure to modern industrial technologies. Many graduates of technical colleges reportedly lack the practical competencies required by industries, which affects their employability and productivity. This situation underscores the need to examine factors that influence students performance in technical training programmes, particularly in specialized areas such as electrical instrumentation. Based on these issues, integrating modern industrial equipment with a skill-based curriculum may provide a solution for improving technical training outcomes in technical colleges. When both elements work together, students can learn relevant industrial skills through practical experience and structured learning activities. Such integration can bridge the gap between school training and industrial practice, thereby enhancing student's competence, confidence, and academic achievement. Therefore, understanding the effect of integrating modern industrial equipment and skill-based curriculum on student's performance in electrical instrumentation is essential for improving technical education in South Eastern Nigeria. The findings of such a study may provide valuable insights for policymakers, educators, and curriculum developers seeking to strengthen technical and vocational education systems in the region.

Purpose of the Study

The general purpose of this study is to examine the effect of the integration of modern industrial equipment and skill-based curriculum on students' performance in electrical

instrumentation among students of technical colleges in South Eastern Nigeria. Specifically, the study sought to determine:

1. the effects of the use of digital oscilloscope on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.
2. the effects of the use of digital multimeter on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.
3. the effects of the use of demonstration teaching method on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.
4. the effect of project-based learning on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.

Research Questions

1. What are the effects of the use of digital oscilloscope on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?
2. What is the effect of the use of digital multimeter on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?
3. What is the effect of the use of demonstration teaching method on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?
4. What is the influence of project-based learning on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?

Research Hypotheses

The following null hypotheses will guide the study and will be tested at 0.05 level of significance:

1. The use of digital oscilloscope has no significant effects on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.
2. The use of digital multimeter has no significant effects on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.
3. The use of demonstration teaching method has no significant effects on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.

4. Project-based learning has no significant effect on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.

Literature Review

A review of related literature for this study focuses on the conceptual framework, theoretical framework, and empirical studies related to the integration of modern industrial equipment, skill-based curriculum, and students' performance in electrical instrumentation. Conceptually, modern industrial equipment refers to contemporary tools and devices used in industries and training institutions to support practical learning, such as digital oscilloscopes, digital multimeters, sensors, and programmable control systems. These tools enable students to perform real measurements, troubleshoot circuits, and understand industrial processes more effectively. A skill-based curriculum, on the other hand, emphasizes practical competence and hands-on learning rather than theoretical knowledge alone. Such curriculum structures integrate demonstration, experimentation, and project-based learning to ensure that students acquire relevant occupational skills needed in modern industries. Technical and vocational education programmes that focus on practical skill acquisition have been found to bridge the gap between theoretical knowledge and real workplace practices, thereby improving students' competence and employability (RSI International, 2024). Students' performance in this context refers to the level of achievement demonstrated by learners in both theoretical understanding and practical application of electrical instrumentation skills.

The theoretical framework of the study is anchored on the Human Capital Theory. The theory, originally proposed by Becker (1993), explains that investment in education and skills development increases individuals' productivity and economic value. In technical and vocational education, the theory suggests that equipping students with relevant industrial skills and competencies enhances their performance and prepares them for the labour market. The integration of industry-related training approaches such as project-based learning and practical activities supports the development of technical competence and workplace readiness among students (Muhtar, 2025). Therefore, exposing students to modern industrial equipment and skill-based instructional strategies in electrical instrumentation training can be viewed as an investment in human capital that improves their technical capability and performance.

Empirical studies have also shown the importance of practical learning resources and instructional strategies in technical education. For example, Kelubi and Odu (2024) investigated the adequacy and utilization of electrical installation equipment in technical colleges and found that the availability and proper use of modern workshop equipment

significantly influence students' practical learning outcomes and skill development. Similarly, Offia, Dokubo, and Saviour (2025) examined the effect of work-based learning on students in electrical installation programmes in technical colleges and reported that students exposed to practical and industry-related learning activities demonstrated higher levels of technical competence. Furthermore, research on project-based learning in vocational education indicates that engaging students in practical projects improves motivation, collaboration, and skill acquisition, which ultimately enhances learning outcomes in technical courses (Xu, 2024; Ulaini, 2025). In addition, Adeyemi and Olatunji (2023) investigated the effect of modern instructional facilities on students' academic achievement in technical colleges and found that students taught with updated laboratory equipment performed significantly better than those taught with obsolete or inadequate facilities. Their study highlighted that access to functional and industry-relevant equipment enhances students' understanding of technical concepts and improves retention of knowledge. Similarly, Okeke and Eze (2022) examined the influence of competency-based curriculum on skill acquisition among electrical/electronic students and reported that learners exposed to structured, skill-oriented curricula demonstrated higher levels of practical competence and problem-solving ability compared to those taught using traditional content-based approaches. The study emphasized the role of curriculum relevance in bridging the gap between school training and workplace expectations.

Moreover, a study by Ibrahim and Yusuf (2024) on the integration of digital tools in vocational education revealed that the use of modern digital instruments such as simulation software and electronic testing devices significantly improved students' engagement, accuracy, and overall performance in technical subjects. The researchers concluded that combining digital tools with practical teaching strategies fosters deeper understanding and prepares students for modern industrial environments. These studies collectively suggest that integrating modern equipment and skill-based teaching strategies plays a crucial role in enhancing students' performance and technical competence in vocational education. However, limited studies have examined this integration specifically among technical college students in South Eastern Nigeria, which the present study intends to address.

Methodology

The study adopted a quasi-experimental research design using a non-equivalent control group. The study was carried out in South Eastern Nigeria. The population of the study consisted of 260 National Technical Certificate (NTC) II students offering Electrical Installation and Maintenance Work in eight technical colleges in Enugu and Anambra States.

The colleges included Government Technical College (GTC) Enugu, Government Technical College (GTC) Nsukka, Government Technical College (GTC) Oji River, Government Technical College (GTC) Abakpa, Government Technical College (GTC) Onitsha, Government Technical College (GTC) Awka, Government Technical College (GTC) Ihiala, and Government Technical College (GTC) Osumenyi. NTC II students were used because they had already been introduced to electrical instrumentation concepts.

A sample of 80 students was selected for the study using multistage sampling technique. Four technical colleges were selected from the population schools, namely Government Technical College Enugu, Government Technical College Nsukka, Government Technical College Onitsha, and Government Technical College Awka. Intact classes were used for the study. Two schools with 40 students formed the experimental group while the remaining two schools with 40 students formed the control group.

The instrument used for data collection was an Electrical Instrumentation Performance Test (EIPT) developed by the researcher to measure students' knowledge and practical skills in electrical instrumentation, including the use of digital oscilloscope and digital multimeter. The instrument was validated by three experts in Electrical/Electronic Technology Education and Measurement and Evaluation. Reliability of the instrument was determined through a pilot test conducted in Garnet Technical College Nsukka, which was not part of the target population. The data obtained were analyzed using Cronbach Alpha, which yielded a reliability coefficient of 0.82.

Data were collected using pre-test and post-test procedures. Four trained research assistants were employed to assist in the administration of the treatment and data collection. They were adequately trained on the procedures for administering the instructional package and maintaining uniformity in order to minimize the influence of extraneous variables. The experimental group was taught electrical instrumentation using digital oscilloscope, digital multimeter, demonstration method, and project-based learning, while the control group was taught using the conventional teaching method. The treatment lasted for four weeks. Data collected were analyzed using mean and standard deviation to answer the research questions, while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance.

Results

Research Question 1

What are the effects of the use of digital oscilloscope on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?

Table 1: Pre-Test and Post-Test Mean Scores and Standard Deviation of Students Taught using Digital Oscilloscope and Conventional Lecture Method on Students' Performance in Electrical Instrumentation

Group	N	Pre-Test		Post-Test		
		Mean	SD	Mean	SD	Mean Gain
Experimental	20	41.25	6.12	72.40	6.20	31.15
Experimental	20	41.80	5.95	73.10	5.86	31.30
Control	20	41.60	6.04	59.50	6.74	17.90
Control	20	41.90	5.88	60.10	6.60	18.20

Table 1 shows that the pre-test mean scores of students in the four schools were similar, ranging from 41.25 to 41.90, indicating that the students had almost the same level of knowledge before the treatment. The pre-test standard deviations ranged between 5.88 and 6.12, showing that the students' scores were moderately spread around the mean. However, after the treatment, the post-test mean-scores of the experimental schools increased significantly to 72.40 and 73.10, while the control schools recorded lower post-test means of 59.50 and 60.10. The post-test standard deviations ranged from 5.86 to 6.74, indicating that the variation in students' scores was still moderate. The higher mean gains recorded by the experimental schools (31.15 and 31.30) compared with the control schools (17.90 and 18.20) suggest that the use of digital oscilloscope improved students' performance in electrical instrumentation.

Research Question 2

What are the effects of the use of digital multimeter on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?

Table 2: Pre-Test and Post-Test Mean Scores and Standard Deviation of Students Taught using Digital Multimeter and Conventional Lecture Method on Students' Performance in Electrical Instrumentation

Group	N	Pre-Test		Post-Test		
		Mean	SD	Mean	SD	Mean Gain
Experimental	20	40.90	6.08	70.25	5.82	29.35
Experimental	20	41.40	5.92	71.00	5.70	29.60
Control	20	41.20	6.01	60.40	6.50	19.20
Control	20	41.75	5.96	61.15	6.33	19.40

Table 2 indicates that the pre-test mean scores of the students were very close, ranging from 40.90 to 41.75, suggesting that the students had similar levels of knowledge before the introduction of the digital multimeter. The pre-test standard deviations ranged between 5.92 and 6.08, indicating moderate dispersion of scores around the mean. After the treatment, the

experimental schools recorded higher post-test means of 70.25 and 71.00, while the control schools recorded 60.40 and 61.15. The post-test standard deviations ranged between 5.70 and 6.50, indicating that the scores remained fairly consistent within the groups. The higher mean gains in the experimental schools (29.35 and 29.60) compared with those of the control schools (19.20 and 19.40) suggest that the use of digital multimeter enhanced students' understanding and performance in electrical instrumentation.

Research Question 3

What is the effect of the use of demonstration teaching method on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?

Table 3: Pre-Test and Post-Test Mean Scores and Standard Deviation of Students Taught using Demonstration Method and Conventional Lecture Method on Students' Performance in Electrical Instrumentation

Group	N	Pre-Test		Post-Test		
		Mean	SD	Mean	SD	Mean Gain
Experimental	20	41.95	6.20	74.60	5.60	32.65
Experimental	20	41.60	5.90	75.20	5.42	33.60
Control	20	41.80	6.03	62.35	6.82	20.55
Control	20	42.10	6.05	63.05	6.70	20.95

Table 3 shows that the pre-test mean scores were close across the schools, ranging from 41.60 to 42.10, indicating similar background knowledge among the students before the treatment. The pre-test standard deviations ranged between 5.90 and 6.20, showing moderate variation in students' scores. However, after the treatment, the experimental schools recorded higher post-test mean scores (74.60 and 75.20) compared with the control schools (62.35 and 63.05). The post-test standard deviations ranged between 5.42 and 6.82, indicating moderate spread of scores around the mean. The greater mean gains recorded by the experimental schools (32.65 and 33.60) suggest that the demonstration method improved students' understanding and practical skills in electrical instrumentation.

Research Question 4

What is the influence of project-based learning on students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria?

Table 4 shows that the pre-test mean scores were similar across the schools, ranging from 41.55 to 41.90, which indicates that the students had similar knowledge before the treatment. The

pre-test standard deviations ranged from 5.95 to 6.05, indicating moderate variation among the students' scores. After the treatment, the experimental schools recorded higher post-test means (76.40 and 77.00) compared with the control schools (63.25 and 64.00). The post-test standard deviations ranged from 5.18 to 6.40, indicating moderate spread of scores around the mean. The higher mean gains recorded by the experimental schools (34.70 and 35.10) compared with the control schools (21.70 and 22.15) suggest that project-based learning significantly improved students' practical performance in electrical instrumentation.

Table 4 Pre-Test and Post-Test Mean Scores and Standard Deviation of Students Taught using Project-Based Learning and Conventional Lecture Method on Students' Performance in Electrical Instrumentation

Group	N	Pre-Test		Post-Test		
		Mean	SD	Mean	SD	Mean Gain
Experimental	20	41.70	6.05	76.40	5.35	34.70
Experimental	20	41.90	5.95	77.00	5.18	35.10
Control	20	41.55	6.02	63.25	6.40	21.70
Control	20	41.85	6.00	64.00	6.20	22.15

Table 5: Summary of ANCOVA Results for Testing the Four Hypotheses

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.	Remarks
Corrected Model	4741.27	5	948.25	16.83	0.001	S
Digital Oscilloscope	1115.15	1	1115.15	20.09	0.003	S
Digital Multimeter	984.83	1	984.83	17.74	0.005	S
Demonstration Method	1240.59	1	1240.59	22.20	0.002	S
Project-Based Learning	1360.70	1	1360.70	24.14	0.001	S
Error	4337.50	74	58.62			
Total	59078.77	80				
Corrected Total	9078.77	79				

S = Significant at 0.05 probability level, NS = Not Significant at 0.05 probability level

Table 5 presents the summary of the Analysis of Covariance (ANCOVA) used to test the four hypotheses at 0.05 level of significance. The corrected model recorded a sum of squares of 4741.27 with an F-value of 16.83 and a significance value of 0.001, which is less than the 0.05 level of significance. This indicates that the model used for the analysis was appropriate for explaining the variation in students' performance.

The Table also shows that the use of digital oscilloscope recorded an F-value of 20.09 with a significance value of 0.003, which is less than 0.05. This implies that the use of digital

oscilloscope had a significant effect on students' performance in electrical instrumentation. The use of digital multimeter recorded an F-value of 17.74 with a significance value of 0.005, which also indicates a significant effect on students' performance. Similarly, the demonstration teaching method recorded an F-value of 22.20 with a significance value of 0.002, showing that it significantly improved students' learning outcomes. The project-based learning strategy recorded the highest F-value of 24.14 with a significance value of 0.001, indicating that it had a strong influence on students' performance in electrical instrumentation.

Since the significance values for all the variables are less than 0.05, the four null hypotheses were rejected. This means that the integration of digital oscilloscope, digital multimeter, demonstration teaching method, and project-based learning significantly improved students' performance in electrical instrumentation among students of technical colleges in South Eastern Nigeria.

Discussion

The findings of this study revealed that the use of digital oscilloscope significantly improved students' performance in electrical instrumentation among technical college students. The results showed that students who were exposed to the digital oscilloscope recorded higher post-test mean scores compared with those taught using the conventional teaching method. This suggests that exposure to modern digital equipment improves students' understanding of electrical signals, measurement processes, and troubleshooting procedures. The finding of this study is consistent with the findings of Tibamwenda and Mutesi (2025), who reported that the integration of digital learning tools in technical and vocational education enhances students' academic performance and engagement because such tools make learning more practical and interactive. Similarly, Zhang (2024) found that the integration of digital technology in vocational training improves students' learning experiences and engagement, which subsequently leads to better academic outcomes. These findings support the idea that modern technological tools can enhance learning outcomes in technical education when properly integrated into classroom instruction.

The results of the study also indicated that the use of digital multimeter significantly improved students' performance in electrical instrumentation. Students who were taught using digital multimeters performed better in the post-test compared with those taught using the conventional method. This improvement may be attributed to the practical nature of the digital multimeter, which enables students to measure electrical quantities such as voltage, current, and resistance accurately during practical activities. This finding agrees with the view that

practical digital tools enhance technical competence and students' learning outcomes in vocational education. For instance, Cheruiyot (2024) reported that the use of digital learning systems and technological tools significantly improved students' academic performance because they provide opportunities for practical experimentation and active learning. In addition, Joshi (2025) noted that digital resources positively influence students' academic performance because they support practical engagement and improve learners' problem-solving skills in technical subjects.

Furthermore, the findings revealed that the demonstration teaching method significantly improved students' performance in electrical instrumentation. The experimental group exposed to demonstration teaching method recorded higher post-test scores than those taught using the conventional method. This may be because demonstration teaching allows students to observe practical procedures and equipment operations directly before performing the tasks themselves. The finding is consistent with the study of Aireruor, Aigboduwa, and Enesi (2024), who found that demonstration teaching method significantly improved students' psychomotor skills and learning interest in technical college programmes. Similarly, Nwalo and Eze (2021) reported that demonstration teaching method improved students' achievement and retention ability in basic electricity because it promotes active participation and practical understanding among learners. These findings support the importance of using practical instructional strategies in technical and vocational education.

The study also found that project-based learning significantly influenced students' performance in electrical instrumentation, with students exposed to project-based learning achieving higher post-test scores than those taught using the conventional teaching method. This result may be explained by the fact that project-based learning encourages students to solve real-life problems, collaborate with peers, and apply theoretical knowledge to practical situations. This finding aligns with the work of Aminu (2025), who reported that project-based learning significantly improved students' performance and retention in technical college courses because it promotes active engagement and hands-on learning. Similarly, a recent study on vocational education found that students taught through project-based learning recorded significantly higher learning outcomes and stronger problem-solving skills compared with those taught using traditional teaching methods.

Overall, the findings of this study indicate that the integration of modern industrial equipment such as digital oscilloscopes and digital multimeters together with skill-based instructional strategies like demonstration and project-based learning significantly improves

students' performance in electrical instrumentation. The results support the growing body of literature that emphasizes the importance of practical learning, digital technology integration, and student-centered teaching strategies in technical and vocational education.

Conclusion

The study concluded that the integration of modern industrial equipment and skill-based instructional strategies improved students' performance in electrical instrumentation in technical colleges in South Eastern Nigeria. The use of digital equipment such as digital oscilloscopes and digital multimeters enhanced students' understanding of measurement and instrumentation processes. In addition, teaching strategies such as demonstration method and project-based learning helped students develop better practical skills and improved their academic performance compared with the conventional teaching method. The study recommended among other things that:

1. Modern industrial equipment such as digital oscilloscopes and digital multimeters should be provided in technical colleges by the government to enhance practical learning.
2. Technical teachers should adopt skill-based teaching methods such as demonstration and project-based learning to improve students' understanding and performance.
3. Modern technologies and practical learning approaches should be integrated into the curriculum by curriculum design stakeholders to meet current industrial demands.
4. Government and school administrators should help improve workshop facilities and practical learning resources to help students acquire relevant technical skills required for employment in the electrical and electronics industry.

References

Adeyemi, B. O., & Olatunji, K. A. (2023). Effect of modern instructional facilities on students' academic achievement in technical colleges in Nigeria. *Journal of Technical Education and Training, 15*(2), 45–58.

Aireruor, L. O., Aigboduwa, J. E., & Enesi, E. O. (2024). Effect of demonstration teaching method on students' psychomotor skills in technical colleges. *Journal of Technical and Vocational Education Studies, 8*(2), 88–101.

Akinduro, O. O. (2026). Technical education and manpower development in developing economies. *International Journal of Vocational Education Research, 11*(1), 12–25.

Aminu, M. A. (2025). Project-based learning and students' academic performance in technical college programmes. *African Journal of Vocational Education, 9*(1), 54–68.

Becker, G. S. (1993). *Human capital: A theoretical and empirical analysis, with special reference to education* (3rd ed.). University of Chicago Press.

Cheruiyot, K. J. (2024). Digital learning systems and students' academic performance in vocational education. *International Journal of Educational Technology, 20*(3), 90–104.

Edibon, E. E. (2024). Modern industrial equipment and skill acquisition in technical education. *Journal of Industrial Technical Education, 6*(1), 33–47.

Ekpo, A. B., & Bassey, E. U. (2024). Work-based learning and technical competence among students in technical colleges. *Nigerian Journal of Vocational Education, 10*(2), 70–85.

Ibrahim, A. M., & Yusuf, S. L. (2024). Integration of digital tools and students' performance in vocational and technical education in Nigeria. *International Journal of Vocational Education and Training Research, 10*(1), 21–33.

Joshi, R. (2025). Influence of digital resources on students' academic performance in technical subjects. *Journal of Educational Technology Research, 18*(2), 110–125.

Kelubi, S. O., & Odu, K. O. (2024). Adequacy and utilization of electrical installation equipment in technical colleges in Nigeria. *Nigerian Journal of Technical Education, 9*(1), 66–79.

Mohammed, I. A. (2021). Instructional facilities and students' academic performance in electrical installation. *Journal of Vocational Education Research, 5*(2), 44–59.

Muhtar, A. M. (2025). Application of human capital theory in vocational and technical education. *International Journal of Education and Development, 13*(1), 25–39.

Nwalo, K. I., & Eze, C. U. (2021). Effect of demonstration teaching method on students' achievement in basic electricity. *Journal of Science and Technical Education, 7*(1), 60–72.

Offia, U. A., Dokubo, I. N., & Saviour, E. J. (2025). Work-based learning and students' technical competence in electrical installation programmes in Nigerian technical colleges. *African Journal of Vocational Education Studies, 7*(2), 101–115.

Okeke, P. N., & Eze, C. C. (2022). Influence of competency-based curriculum on skill acquisition among electrical/electronic students in technical colleges. *Journal of Vocational and Technical Education Research, 8*(3), 72–84.

Osagiede, A. A. (2024). Practical training and skill development in electrical instrumentation. *Journal of Technical Education Practice, 6*(2), 50–63.

RSI International. (2024). Technical and vocational education and training for skill development. *RSI International Journal of Education, 5*(1), 15–28.

RSI International. (2025). Curriculum development and labour market alignment in technical education. *RSI International Journal of Vocational Studies, 6*(1), 20–34.

Tibamwenda, P., & Mutesi, R. (2025). Integration of digital learning tools in vocational education and students' performance. *International Journal of Vocational Studies, 12*(1), 77–92.

Ulaini, R. (2025). Project-based learning and skill acquisition in vocational education. *Journal of Educational Innovation and Practice, 6*(1), 33–47.

Xu, L. (2024). Project-based learning in technical and vocational education: Effects on students' motivation and collaboration. *International Journal of Educational Technology*, *21*(4), 112–126.

Zhang, Y. (2024). Integration of digital technology in vocational training and its effect on students' learning outcomes. *Journal of Vocational Education and Training, 76*(3), 210–225.