



Utilization Of Computer-Aided Design and Digital Measurement Tools for Teaching Electrical and Electronics Technology in Tertiary Institutions in Niger State, Nigeria

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ABSTRACT

The study examined the utilization of Computer-Aided Design (CAD) and digital measurement tools for teaching Electrical and Electronics Technology in tertiary institutions in Niger State, Nigeria. The study was motivated by the increasing importance of digital technologies in contemporary electrical and electronics education and the need to prepare students with practical competencies relevant to modern industrial practice. Two research questions and two null hypotheses guided the study. A descriptive survey research design was adopted for the study. The population comprised lecturers teaching Electrical and Electronics Technology-related courses in selected tertiary institutions in Niger State. A sample of 120 lecturers was selected using a stratified sampling technique. Data were collected using a structured questionnaire titled Computer-Aided Design and Digital Measurement Tools Utilization Questionnaire (CAD-DMTUQ). The instrument was validated by experts in Electrical and Electronics Technology Education, Educational Technology and Measurement and Evaluation, while its reliability was established using Cronbach's alpha, yielding a coefficient of 0.88. Mean and standard deviation were used to answer the research questions, while independent-samples t-test was used to test the hypotheses at 0.05 level of significance. The findings indicated that CAD tools were utilized to a moderate extent for circuit design, schematic drawing, simulation and technical documentation. Digital measurement tools, including digital multimeters, digital oscilloscopes, digital wattmeters and digital signal generators, were also utilized to a moderate extent. The findings further showed no significant difference between lecturers in universities and other tertiary institutions regarding utilization of CAD and digital measurement tools. The study concludes that improved access, training, maintenance and institutional support are required to strengthen technology-supported Electrical and Electronics Technology instruction.

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INTRODUCTION

The rapid transformation of technology has changed the nature of technical and vocational education and has created increasing expectations for tertiary institutions to produce graduates who can function effectively in technology-driven workplaces. Electrical and

Electronics Technology is particularly affected by this transformation because contemporary electrical and electronics practice relies heavily on computer-based design, simulation, measurement, testing, diagnosis and documentation. Consequently, teaching and learning in Electrical and Electronics Technology

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can no longer depend exclusively on conventional drawing instruments, analogue measuring devices and teacher-centred demonstrations. The integration of Computer-Aided Design (CAD), digital simulation and modern measurement technologies provides opportunities for students to acquire practical competencies that are more closely aligned with contemporary industrial practice.

Computer-Aided Design refers to the use of computer software to create, modify, analyse, simulate and document technical designs. In electrical and electronics education, CAD applications can be used for schematic development, circuit layout, electrical installation drawings, printed circuit-board design, circuit simulation and technical documentation. Computer-based design environments also permit students to make modifications rapidly, test alternatives and visualize circuit behaviour before constructing physical systems (Saidu et al., 2019). Earlier work in Nigerian engineering education observed that modern electrical engineering practice had become increasingly dependent on computers for design drawings, analysis, optimization and simulation, thereby creating a need for educators to prepare students for computer-supported engineering practice (Okafor et al., n.d.).

The importance of CAD in technical education has also been recognized in Nigerian studies. Busari and Ayoola (2016) and Saidu, Babawuro, et al. (2019) reported that CAD had not received sufficient attention within some technical education curricula and those lecturers and students continued to rely on traditional manual drafting approaches. Their study argued that CAD packages could be integrated into technical education programmes to improve contemporary technical drawing and design competencies. Similarly, Robinson and Amadi (2015/2016) investigated CAD in the teaching of electrical drafting in Nigerian technical colleges and demonstrated the relevance of computer-based design approaches to electrical education.

The application of CAD is particularly important in Electrical and Electronics Technology because electrical systems increasingly require

accurate graphical representation and simulation before physical implementation. Modern electrical engineering curricula already recognize the relationship between network analysis, computer-aided design and electrical measurement. For example, an electrical engineering curriculum at the University of Ibadan includes *Network Analysis and Computer Aided Design* and *Electrical Measurements*, demonstrating the complementary nature of computer-based design and measurement competencies. Thus, tertiary-level instruction should expose students to both design technologies and modern instruments for verifying and analysing electrical systems.

Digital measurement tools constitute another important dimension of contemporary Electrical and Electronics Technology instruction. Such tools include digital multimeters, digital oscilloscopes, digital wattmeters, digital insulation testers, digital signal generators and other computer-supported measurement systems. A digital multimeter, for example, allows the measurement of electrical quantities such as voltage, current and resistance and provides a digital display that facilitates accurate reading and interpretation of measurements. Digital oscilloscopes further permit learners to observe electrical waveforms and investigate amplitude, frequency and signal distortion. Their instructional value has been demonstrated in Nigerian technical education research, where students exposed to digital oscilloscopes performed better on selected electronics concepts than students taught with conventional oscilloscopes.

The relevance of digital measurement tools is also reflected in Nigerian technical education curriculum documents. The National Board for Technical Education (NBTE) curriculum for Electrical and Electronics Engineering specifically identifies digital multimeters, analogue multimeters and digital oscilloscopes among the instruments students should encounter in electrical and electronic measurement and instrumentation. The curriculum emphasizes both theoretical knowledge and practical application of electrical and electronic instruments. This suggests that the effective utilization of modern measurement equipment is not merely an optional

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technological innovation but an important component of practical technical education.

At the tertiary level, institutions require lecturers who possess appropriate technological knowledge and the pedagogical ability to integrate digital technologies into subject-specific instruction. This requirement corresponds with the Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra and Koehler (2006), which emphasizes the interaction of technological knowledge, pedagogical knowledge and content knowledge. A lecturer may possess knowledge of electrical circuits and also know how to operate CAD software, but effective instructional integration requires the ability to connect the technology with appropriate pedagogical approaches and specific subject content. Recent Nigerian research similarly indicates that TPACK and digital competence are important predictors of readiness for technology-supported instruction.

The Nigerian context makes this issue particularly significant. Evidence from Nigerian teacher-education research indicates that technological knowledge, teachers' knowledge and knowledge of technology integration are associated with technology integration practices. Recent research has also emphasized the importance of systematic TPACK development and practical technology exposure for Nigerian educators. These findings imply that providing equipment alone may not guarantee effective classroom utilization; lecturers also need appropriate professional development and opportunities to develop confidence in integrating digital tools into instruction.

Niger State provides an important setting for investigating this issue because it has tertiary institutions involved in science, technology and vocational education. The Federal University of Technology, Minna, for instance, offers Electrical and Electronics Technology Education and maintains laboratories containing digital multimeters, digital wattmeters, digital insulation testers, oscilloscopes, spectrum analysers and other electrical/electronic laboratory equipment. The availability of such equipment provides an opportunity for technology-supported instruction,

but the existence of equipment does not necessarily mean that lecturers utilize it frequently or effectively.

Recent research in Nigeria has further emphasized digital competencies among Electrical and Electronics Technology Education lecturers. A 2025 study specifically examined the digital competencies required by Electrical and Electronics Technology Education lecturers for utilizing emerging technologies in Kaduna and Niger States, indicating growing scholarly attention to technology integration within the field. However, there remains a need to establish empirically the extent to which CAD and digital measurement tools are actually utilized for teaching Electrical and Electronics Technology in tertiary institutions in Niger State.

The present study therefore focuses specifically on the utilization of CAD and digital measurement tools by lecturers in tertiary institutions in Niger State. The study is anchored in the view that effective technical education should unite theoretical knowledge with practical, technology-supported learning experiences. Determining the extent of utilization of these technologies can provide evidence for curriculum improvement, staff development, equipment provision and institutional planning.

STATEMENT OF THE PROBLEM

Electrical and Electronics Technology is a practical-oriented field in which students are expected to acquire competencies in electrical circuit analysis, electronic circuit construction, measurement, testing, troubleshooting, design and maintenance. Traditionally, much of this instruction has relied on manual technical drawing, conventional measuring instruments, teacher demonstrations and physical circuit construction. Although these approaches remain useful, they may not adequately expose students to the digital technologies increasingly used in contemporary electrical and electronics workplaces.

The growing availability of CAD software, circuit simulation packages and digital measurement instruments provides opportunities to modernize Electrical and Electronics



Technology instruction. CAD can facilitate accurate circuit representation, modification, simulation and documentation, while digital measurement instruments can improve the observation, recording and interpretation of electrical quantities. Nigerian studies have already established the relevance of CAD to technical education and electrical drafting, but have also identified continued dependence on traditional approaches and inadequate curricular attention to CAD.

The problem may also involve the gap between equipment availability and actual instructional utilization. An institution may possess digital multimeters, oscilloscopes, signal generators or CAD-capable computers, yet lecturers may use these resources infrequently because of inadequate training, insufficient equipment, maintenance problems, unreliable electricity supply, limited software access, large classes or lack of technical support. The existence of laboratory equipment at tertiary institutions therefore does not automatically establish that the equipment is being effectively integrated into classroom and laboratory instruction.

This concern is important because the NBTE curriculum explicitly includes modern electrical and electronic measurement instruments such as digital multimeters and digital oscilloscopes, suggesting that students should acquire practical competencies in their use. Similarly, contemporary engineering curricula incorporate computer-aided network analysis and electrical measurements as components of professional preparation. If lecturers do not adequately utilize these technologies, students may graduate with limited experience in the digital design and measurement practices required in contemporary electrical and electronics occupations.

Furthermore, the effectiveness of technology integration depends not only on the presence of technology but also on lecturers' technological and pedagogical competencies. Research on Nigerian educators indicates that technological knowledge and knowledge of technology integration are relevant to actual technology use in teaching. Therefore, there is a

need to investigate the actual extent of utilization rather than merely assuming that the presence of equipment translates into effective instructional practice.

The specific problem addressed by this study is therefore the apparent uncertainty regarding the extent to which Computer-Aided Design and digital measurement tools are utilized for teaching Electrical and Electronics Technology in tertiary institutions in Niger State. Without empirical evidence concerning their level of utilization, it becomes difficult for institutions, curriculum planners and policymakers to determine appropriate interventions for staff development, equipment provision, curriculum review and laboratory improvement. This study consequently seeks to determine the extent of utilization of CAD and digital measurement tools for teaching Electrical and Electronics Technology in tertiary institutions in Niger State, Nigeria.

Purpose of the Study

The main purpose of the study was to determine the utilization of Computer-Aided Design and digital measurement tools for teaching Electrical and Electronics Technology in tertiary institutions in Niger State, Nigeria.

Specifically, the study sought to:

1. determine the extent to which Computer-Aided Design tools are utilized for teaching Electrical and Electronics Technology in tertiary institutions in Niger State; and
2. determine the extent to which digital measurement tools are utilized for teaching Electrical and Electronics Technology in tertiary institutions in Niger State.

Research Questions

The following research questions guided the study:

1. To what extent are Computer-Aided Design tools utilized for teaching Electrical and Electronics Technology in tertiary institutions in Niger State?
2. To what extent are digital measurement tools utilized for teaching Electrical and



Electronics Technology in tertiary institutions in Niger State?

Research Hypotheses

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

H₀₁: There is no significant difference between the mean ratings of lecturers in universities and lecturers in other tertiary institutions regarding the utilization of Computer-Aided Design tools for teaching Electrical and Electronics Technology in Niger State.

H₀₂: There is no significant difference between the mean ratings of lecturers in universities and lecturers in other tertiary institutions regarding the utilization of digital measurement tools for teaching Electrical and Electronics Technology in Niger State.

METHODOLOGY

The study adopted a descriptive survey research design. The study was conducted in Niger State, Nigeria. The state has tertiary institutions offering programmes related to Electrical and Electronics Technology, Engineering and Technology Education. The study covered selected tertiary institutions offering relevant Electrical and Electronics Technology-related programmes. The population of the study comprised 150 lecturers involved in teaching Electrical and Electronics Technology and related courses in selected tertiary institutions in Niger State.

A sample of 120 lecturers was selected using a stratified sampling technique to ensure representation of lecturers from universities and other tertiary institutions. Data were collected using a researcher-developed questionnaire titled Computer-Aided Design and Digital Measurement Tools Utilization Questionnaire (CAD-DMTUQ). The questionnaire was structured into two sections. Section A obtained demographic information, while Section B contained items measuring utilization of: CAD software for electrical schematic design; circuit simulation

packages; electrical installation drawing software; PCB design applications; circuit analysis software; digital multimeters; digital oscilloscopes; digital wattmeters; digital signal/function generators; digital insulation/continuity testers; and other computer-supported measurement instruments. The questionnaire adopted a four-point rating scale. A criterion means of 2.50 was adopted. Mean scores of 2.50 and above indicated utilization to a high extent, while mean scores below 2.50 indicated utilization to a low extent.

The instrument was subjected to face and content validation by experts in Electrical and Electronics Technology Education, Educational Technology and Measurement and Evaluation as suggested by experts (Saidu et al., 2023). Their observations concerning clarity, relevance, adequacy and appropriateness of the items were incorporated into the final instrument. A pilot test was conducted using lecturers from a tertiary institution outside the study area. The reliability of the questionnaire was established using Cronbach's alpha, which yielded an overall reliability coefficient of 0.88. The coefficient was considered adequate for the study.

The researchers administered the questionnaire to the sampled lecturers with the assistance of trained research assistants. Completed questionnaires were retrieved, screened and prepared for statistical analysis. Mean and standard deviation were used to answer the research questions. Independent-samples t-test was used to test the hypotheses at 0.05 level of significance. The null hypothesis was rejected where the p-value was less than 0.05 and retained where the p-value was greater than 0.05.

RESULTS AND DISCUSSION OF FINDINGS

Research Question 1

To what extent are Computer-Aided Design tools utilized for teaching Electrical and Electronics Technology in tertiary institutions in Niger State?



Table 1: Mean and Standard Deviation of Lecturers' Ratings on Utilization of CAD Tools

S/N	Computer-Aided Design Tools/Applications	Mean	SD	Decision
1	Electrical schematic/Circuit drawing software	2.91	0.86	High Extent
2	Circuit simulation software	2.82	0.91	High Extent
3	AutoCAD/electrical drawing applications	2.74	0.89	High Extent
4	PCB design software	2.58	0.94	High Extent
5	Computer-based circuit analysis software	2.67	0.88	High Extent
6	CAD for electrical installation drawings	2.61	0.93	High Extent
7	CAD for technical documentation	2.73	0.87	High Extent
8	CAD for demonstration of circuit designs	2.79	0.85	High Extent
	Grand Mean	2.73	0.89	High Extent

Table 1 shows that the grand mean of 2.73 is above the criterion mean of 2.50. This indicates that lecturers utilized Computer-Aided Design tools to a high extent for teaching Electrical and Electronics Technology. Circuit/schematic drawing had the highest mean of 2.91, followed by circuit simulation software with a mean of 2.82.

PCB design recorded the lowest mean of 2.58, although it was still above the criterion mean.

Research Question 2

To what extent are digital measurement tools utilized for teaching Electrical and Electronics Technology in tertiary institutions in Niger State?

Table 2: Mean and Standard Deviation of Lecturers' Ratings on Utilization of Digital Measurement Tools

S/N	Digital Measurement Tool	Mean	SD	Decision
1	Digital multimeter	2.88	0.82	High Extent
2	Digital oscilloscope	2.64	0.91	High Extent
3	Digital wattmeter	2.52	0.96	High Extent
4	Digital signal/function generator	2.47	0.98	Low Extent
5	Digital insulation tester	2.41	0.97	Low Extent
6	Digital continuity/component tester	2.68	0.87	High Extent
7	Computer-based data acquisition equipment	2.31	1.01	Low Extent
8	Digital frequency/capacitance measurement instruments	2.46	0.95	Low Extent
	Grand Mean	2.54	0.93	High Extent

Table 2 indicates a grand mean of 2.54, which is slightly above the criterion mean of 2.50. Therefore, digital measurement tools were utilized to a high extent overall. Digital multimeters had the highest mean of 2.88, while computer-based data acquisition equipment had the lowest mean of 2.31. This suggests that basic digital measuring instruments are more commonly utilized than

advanced computer-supported measurement systems.

Hypothesis 1

H₀₁: There is no significant difference between the mean ratings of lecturers in universities and lecturers in other tertiary institutions regarding the utilization of Computer-Aided Design tools.

Table 3: Independent-Samples t-Test of Lecturers' Ratings on Utilization of CAD Tools

Institution Type	N	Mean	SD	t-cal.	df	p-value	Decision
Universities	70	2.71	0.52				
Other tertiary institutions	50	2.64	0.55	0.74	118	0.461	Retain H ₀₁

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Table 3 shows that university lecturers had a mean rating of 2.71, while lecturers in other tertiary institutions had a mean rating of 2.64. The calculated t-value of 0.74 at 118 degrees of freedom produced a p-value of 0.461, which is greater than 0.05. Therefore, the null hypothesis was retained. This indicates that there was no statistically significant difference between

university lecturers and lecturers in other tertiary institutions in their utilization of CAD tools.

Hypothesis 2

H₀₂: There is no significant difference between the mean ratings of lecturers in universities and lecturers in other tertiary institutions regarding the utilization of digital measurement tools.

Table 4: Independent-Samples t-Test of Lecturers' Ratings on Utilization of Digital Measurement Tools

Institution Type	N	Mean	SD	t-cal.	df	p-value	Decision
Universities	70	2.58	0.57				
Other tertiary institutions	50	2.49	0.53	0.91	118	0.365	Retain H ₀₂

Table 4 shows that university lecturers recorded a mean of 2.58, while lecturers in other tertiary institutions recorded a mean of 2.49. The calculated t-value of 0.91 with 118 degrees of freedom gave a p-value of 0.365, which is greater than 0.05. Thus, the null hypothesis was retained. The result indicates that there was no significant difference between the two groups in the utilization of digital measurement tools.

The finding from Research Question 1 revealed that Computer-Aided Design tools were utilized to a high extent for teaching Electrical and Electronics Technology, with a grand mean of 2.73. The result suggests that lecturers are increasingly incorporating computer-based design applications into instructional activities such as electrical schematic drawing, circuit simulation, technical documentation and electrical installation drawing. This finding is consistent with the argument of Okafor et al. that modern electrical engineering practice increasingly depends on computer-based design, analysis and simulation and that engineering educators therefore need to prepare students for digitally supported professional practice.

The finding is also consistent with Robinson and Amadi's study of CAD in electrical drafting, which demonstrated the relevance of CAD to electrical education in Nigeria. However, the present finding differs in emphasis from Busari and Ayoola (2016), who reported that CAD had not been accorded sufficient importance in technical education curricula and that traditional

manual drafting remained dominant. The difference may be associated with increasing availability of digital technologies, changing curriculum expectations and improved technological awareness among tertiary-level lecturers.

The relatively lower mean recorded for PCB design suggests that utilization may not be uniform across all CAD applications. While lecturers may be comfortable using CAD for basic schematic drawing and simulation, more specialized applications such as PCB design may require additional software, hardware, training and technical expertise. This observation supports the TPACK perspective of Mishra and Koehler (2006), which emphasizes that meaningful technology integration requires the intersection of technological knowledge, pedagogical knowledge and content knowledge.

The finding from Research Question 2 showed that digital measurement tools were utilized to a high extent overall, with a grand mean of 2.54. However, the relatively narrow margin above the criterion mean indicates that utilization is not particularly strong across all categories. Digital multimeters recorded the highest mean, while computer-based data acquisition systems (Saidu, Magnus, et al., 2019), digital insulation testers and some specialized instruments recorded lower means. This pattern is understandable because digital multimeters are relatively accessible and fundamental to electrical and electronics laboratory activities.

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The finding agrees with the direction of the NBTE Electrical and Electronics Engineering curriculum, which explicitly identifies digital multimeters and digital oscilloscopes as important instruments in electrical and electronic measurement and instrumentation. It is also consistent with research showing that digital oscilloscopes can enhance the teaching and learning of electronics concepts. The result further corresponds with contemporary laboratory practice in which digital measurement instruments provide more direct and easily interpreted measurement information.

The relatively low utilization of computer-based data acquisition equipment indicates an area requiring institutional attention. Modern engineering education increasingly connects measurement with computer-based recording, visualization and analysis. National Instruments, for example, describes integrated laboratory environments in which circuit simulation, digital multimeters, oscilloscopes, function generators and computer-based instruments are combined to support electronics learning. Therefore, tertiary institutions in Niger State could move beyond basic digital instruments toward integrated measurement and data-acquisition environments.

The findings of Hypothesis 1 revealed that there was no significant difference between university lecturers and lecturers in other tertiary institutions regarding CAD utilization. This suggests that institution type did not substantially determine lecturers' reported use of CAD. The result may indicate that technology integration is influenced more by individual competence, access, institutional support, professional development and teaching requirements than by institutional category alone. This interpretation is compatible with Nigerian research indicating that technology integration is associated with technological knowledge and knowledge for integrating technology rather than simply teachers' institutional characteristics.

Similarly, Hypothesis 2 showed no significant difference between university lecturers and lecturers in other tertiary institutions regarding digital measurement tool utilization. The finding

suggests that both groups operate under broadly similar conditions regarding the use of modern measurement technologies. This could mean that challenges such as equipment availability, maintenance, technical support, electricity supply and staff training may cut across different categories of tertiary institutions.

The overall findings support the growing argument that technology integration in Nigerian education should involve both the provision of equipment and the development of lecturers' technological competencies. Recent Nigerian research on TPACK has emphasized the importance of systematic technological, pedagogical and content knowledge for effective digital instruction. The findings therefore suggest that strengthening Electrical and Electronics Technology education requires a balanced approach involving hardware, software, curriculum, lecturer competence and institutional support.

CONCLUSION

The study examined the utilization of Computer-Aided Design and digital measurement tools for teaching Electrical and Electronics Technology in tertiary institutions in Niger State, Nigeria. Based on the findings, it was concluded that Computer-Aided Design tools were utilized to a high extent, particularly for electrical schematic drawing, circuit simulation, technical documentation and electrical design activities. Digital measurement tools were also utilized to a high extent overall, although their utilization was stronger for basic instruments such as digital multimeters than for advanced computer-based measurement and data-acquisition systems.

The study further established that there were no significant differences between lecturers in universities and those in other tertiary institutions regarding the utilization of either CAD or digital measurement tools. The implication is that technology integration should not be viewed simply as an institutional-type issue. Rather, sustained utilization requires appropriate equipment, relevant software, lecturer competence, technical support, maintenance and supportive institutional policies.

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For Electrical and Electronics Technology education to remain relevant to modern industrial practice, tertiary institutions in Niger State should continue to move from predominantly conventional instructional approaches toward integrated environments in which CAD, simulation, digital measurement and practical experimentation work together.

RECOMMENDATIONS

Based on the findings, the following recommendations were made:

1. Tertiary institutions should provide adequate CAD facilities by equipping Electrical and Electronics Technology laboratories and computer laboratories with relevant CAD, circuit simulation, electrical drawing and PCB design software.
2. Regular professional development programmes should be organized for lecturers to improve their competencies in CAD applications, circuit simulation, digital measurement, data acquisition and other emerging instructional technologies.
3. Institutions should upgrade digital measurement facilities by providing adequate digital multimeters, digital oscilloscopes, signal generators, digital wattmeters, insulation testers and computer-based data-acquisition systems.
4. CAD and digital measurement applications should be more strongly embedded in course delivery, practical laboratory exercises, student projects and assessment activities rather than being treated merely as supplementary instructional resources.
5. Institutions should establish maintenance and technical-support systems to ensure that computers, software licences, digital instruments and laboratory equipment remain functional and available for instructional use.
6. Electricity and ICT infrastructure should be strengthened because reliable power supply, adequate computers and stable network connectivity are essential for sustained use of digital technologies.
7. Industry–institution collaboration should be encouraged so that lecturers and students can be exposed to current CAD platforms, digital instrumentation and measurement practices used in modern electrical and electronics industries.
8. Curriculum planners should periodically review Electrical and Electronics Technology curricula to ensure that CAD, circuit simulation, digital instrumentation, data acquisition and other emerging technologies reflect current industrial practice.

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