

ASSESSMENT OF AUTOCAD PROFICIENCY AMONG CIVIL ENGINEERING STUDENTS IN CROSS RIVER STATE, NIGERIA: IMPLICATIONS FOR ADVANCING CONTEMPORARY CIVIL ENGINEERING PRACTICES

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Abstract

In the rapidly evolving field of civil engineering, proficiency in Computer-Aided Design (CAD) tools like AutoCAD is pivotal for modern design and construction practices. This study assesses the AutoCAD proficiency levels of civil engineering students in Cross River State, Nigeria, exploring its implications for advancing contemporary civil engineering practices. Using a descriptive survey design, data were collected from 384 students across three tertiary institutions through structured questionnaires and practical AutoCAD skill tests. Findings revealed that 62% of students demonstrated moderate proficiency, with significant gaps in advanced features like 3D modeling and parametric design. Demographic analysis indicated no significant gender-based differences, but proficiency varied by academic level, with final-year students outperforming others. Challenges included limited access to updated software, inadequate training facilities, and outdated curricula. These findings underscore the need for curriculum reform, enhanced training infrastructure, and industry-academia collaboration to align student skills with global standards. Recommendations include integrating advanced AutoCAD modules, establishing CAD laboratories, and fostering partnerships with engineering firms to enhance practical exposure. This study highlights the critical role of AutoCAD proficiency in preparing students for innovative civil engineering practices, contributing to sustainable infrastructure development in Nigeria.

Keywords: AutoCAD, Civil Engineering, Proficiency, CAD training, curriculum reform

Introduction

In the tapestry of modern civil engineering, where precision and innovation interweave to shape the built environment, Computer-Aided Design (CAD) tools like AutoCAD stand as indispensable threads. AutoCAD, developed by Autodesk, has revolutionized how engineers visualize, design, and execute projects, offering unparalleled accuracy, efficiency, and versatility in creating 2D and 3D models. In Nigeria, a nation striving to bridge infrastructural gaps amidst rapid urbanization, the proficiency of civil engineering students in AutoCAD is not merely a skill but a cornerstone for advancing contemporary practices that demand sustainability, resilience, and technological integration.

The global civil engineering landscape has undergone a paradigm shift with the advent of Construction 4.0, characterized by digital tools like Building Information Modeling (BIM), virtual reality, and advanced CAD systems. AutoCAD remains a foundational tool, enabling engineers to design complex structures, perform simulations, and collaborate seamlessly with stakeholders. Studies, such as Nyemba (2023), emphasize that AutoCAD's ability to reduce errors, optimize designs, and enhance productivity makes it a critical skill for civil engineering graduates. However, in developing contexts like Nigeria, the adoption of such technologies in educational settings lags, often due to resource constraints and outdated curricula.

In Nigeria, engineering education faces challenges including inadequate infrastructure, limited access to modern software, and a disconnect between academic training and industry needs. Research by Oluwadare et al. (2015) at Afe Babalola University highlighted that while AutoCAD enhances student engagement and interest in technical drawing, its integration into curricula is often superficial, focusing on basic 2D drafting rather than advanced applications like 3D modeling or parametric design. Similarly, a study in North-Eastern Nigeria by Abubakar et al. (2015) found that lecturers' proficiency in AutoCAD was moderate, limiting their ability to train students effectively. These gaps are particularly pronounced in regions like Cross River State, where educational institutions grapple with funding shortages and technological lag.

The importance of AutoCAD proficiency extends beyond technical competence. It equips students to address contemporary challenges such as sustainable design, low-carbon construction, and resilient infrastructure. For instance, Lotfy et al. (2021) argue that proficiency in CAD tools enables engineers to integrate eco-friendly materials and optimize structural designs, aligning with global sustainability goals. In Nigeria, where infrastructure deficits exacerbate environmental and economic challenges, skilled graduates can drive innovation in projects like smart cities and flood-resistant structures.

Despite its significance, few studies have specifically assessed AutoCAD proficiency among civil engineering students in Cross River State. This region, known for its tourism-driven economy and infrastructural ambitions, requires a workforce adept in modern design tools to support projects like the Calabar-Ogoja Highway and urban renewal initiatives. This study fills this gap by evaluating students' proficiency levels, identifying barriers, and exploring implications for advancing civil engineering practices. It addresses the following research questions:

- What is the level of AutoCAD proficiency among civil engineering students in Cross River State?
- How do demographic factors influence proficiency levels?
- What are the barriers to effective AutoCAD training?
- What are the implications for advancing contemporary civil engineering practices?

Methodology

Research Design

This study adopted a descriptive survey design to assess AutoCAD proficiency among civil engineering students in Cross River State, Nigeria. The design facilitated the collection of quantitative and qualitative data through structured questionnaires and practical skill tests, ensuring a comprehensive evaluation of proficiency levels and associated factors.

Population and Sample

The population comprised 1,200 civil engineering students across three tertiary institutions in Cross River State: University of Calabar (UNICAL), Cross River University of Technology (CRUTECH), and Federal College of Education (Technical), Obudu. A sample size of 384 students was determined using the Yamane (1967) formula at a 95% confidence level. Stratified random sampling ensured proportional representation across institutions, academic levels (100–500 levels), and gender.

Demographic Profile of Participants

Table 1

Presents the demographic characteristics of the participants

Variable	Category	Frequency	Percentage (%)
Gender	Male	230	59.9
	Female	154	40.1
Academic Level	100 Level	76	19.8
	200 Level	84	21.9
	300 Level	90	23.4
	400 Level	82	21.4
	500 Level	52	13.5
Institution	UNICAL	160	41.7
	CRUTECH	140	36.5
	FCE (Technical)	84	21.9
Age Group	18–22 years	200	52.1
	23–27 years	140	36.5
	28+ years	44	11.5

Data Collection Instruments

Two instruments were used:

- AutoCAD Proficiency Questionnaire (APQ): A 20-item questionnaire assessed students' self-reported proficiency in AutoCAD functions (e.g., 2D drafting, 3D modeling, annotations). Items were rated on a 4-point Likert scale (1 = Not Proficient, 4 = Highly Proficient). The instrument

was validated by three experts in civil engineering and educational measurement, yielding a Cronbach Alpha reliability coefficient of 0.79.

- AutoCAD Skill Test (AST): A practical test required students to complete tasks such as creating a 2D floor plan, 3D structural model, and annotating a design within 90 minutes. Scores were graded on accuracy, completeness, and efficiency (maximum score: 100).

Procedure

Data collection occurred between March and April 2025. Questionnaires were administered in lecture halls, while skill tests were conducted in computer laboratories equipped with AutoCAD 2025. Ethical considerations included obtaining informed consent, ensuring anonymity, and securing institutional approval. Data were analyzed using descriptive statistics (mean, standard deviation) for proficiency levels, t-tests for gender differences, and ANOVA for variations across academic levels. Qualitative responses on barriers were thematically analyzed.

Results

The assessment of AutoCAD proficiency among civil engineering students in Cross River State, Nigeria, provided detailed insights into their skill levels, demographic influences, and barriers to effective training. The findings are presented below with additional depth, supported by quantitative and qualitative data analyses.

Proficiency Levels

The AutoCAD Skill Test (AST) results, summarized in Table 2, revealed a spectrum of proficiency among the 384 participants. The overall mean proficiency score was 54.2 (SD = 8.4), indicating moderate proficiency across the sample. A breakdown of performance by AutoCAD function highlighted distinct strengths and weaknesses:

Table 2

Proficiency Level

Proficiency Level	Score Range	Frequency	Percentage (%)	Mean Score	SD
Low	0–39	80	20.8	32.5	5.2
Moderate	40–69	238	62.0	54.8	7.1
High	70–100	66	17.2	78.3	6.8

Students demonstrated relative competence in basic 2D drafting tasks, such as creating floor plans and sectional views, with a mean score of 68.5 (SD = 6.2). This proficiency reflects familiarity with foundational AutoCAD tools like lines, polylines, and annotations, which are typically emphasized

in early coursework. However, performance in advanced functions was notably weaker. For 3D modeling, which included tasks like creating structural models and extruding 2D plans, the mean score was 45.3 (SD = 7.8). Parametric design, requiring knowledge of constraints and dynamic blocks, recorded the lowest mean score of 42.7 (SD = 8.1). These gaps suggest limited exposure to advanced AutoCAD applications, which are critical for modern civil engineering tasks like structural analysis and Building Information Modeling (BIM) integration.

Qualitative responses from the AutoCAD Proficiency Questionnaire (APQ) corroborated these findings. Approximately 68% of students reported confidence in basic drafting but expressed discomfort with 3D tools, citing insufficient training and practice opportunities. One respondent noted, “We only learn 2D in class; 3D is taught briefly, but we don’t have enough lab time to practice.” This indicates a curriculum bias toward foundational skills, potentially misaligned with industry expectations.

Demographic Influences

An independent t-test examining gender differences in proficiency showed no significant variation ($t(382) = 1.12, p = 0.27$). Male students (mean = 54.6, SD = 8.3) performed similarly to female students (mean = 53.7, SD = 8.5), suggesting that gender does not significantly influence AutoCAD proficiency in this context. This finding contrasts with earlier studies, such as Adebayo et al. (2018), which reported slight male advantages in technical drawing due to higher exposure to technology. The absence of gender disparity in this study may reflect improved access to computing resources among female students in recent years.

Analysis of variance (ANOVA) revealed significant differences across academic levels ($F(4,379) = 12.34, p < 0.001$). Post-hoc Tukey tests indicated that 500-level students (mean = 65.8, SD = 7.2) significantly outperformed 100-level (mean = 48.2, SD = 8.9) and 200-level students (mean = 50.4, SD = 8.3). This progression suggests that prolonged exposure to AutoCAD coursework and project-based learning enhances proficiency. However, 300-level (mean = 55.1, SD = 7.6) and 400-level students (mean = 57.3, SD = 7.4) showed only marginal improvements, indicating a plateau in skill development mid-program. This could be attributed to repetitive course content or limited access to advanced training modules.

Institution-wise analysis showed slight variations. Students at the University of Calabar (UNICAL) recorded a mean score of 56.2 (SD = 8.0), followed by Cross River University of Technology (CRUTECH) at 54.1 (SD = 8.6), and Federal College of Education (Technical), Obudu, at 51.8 (SD = 8.2). These differences were not statistically significant ($F(2,381) = 2.45, p = 0.09$), but qualitative data suggested that UNICAL’s slightly better performance may stem from access to a dedicated CAD lab, unlike the other institutions.

Barriers to AutoCAD Proficiency

Thematic analysis of open-ended APQ responses identified four primary barriers, with additional nuances:

- **Limited Access to Software:** 78% of students reported using outdated AutoCAD versions (e.g., 2018 or 2020) due to high licensing costs (approximately \$1,700 annually for commercial versions). Many relied on trial versions or pirated software, which restricted access to advanced features.

- **Inadequate Training Facilities:** Only 45% of respondents had access to institutional CAD labs, with an average of 10–15 functional computers per lab for class sizes exceeding 50 students. Personal laptops often lacked the specifications (e.g., 16GB RAM, dedicated graphics) required for AutoCAD 2025.
- **Outdated Curricula:** 65% of students noted that AutoCAD training focused on basic 2D drafting, with minimal coverage of 3D modeling, rendering, or BIM integration. This aligns with Oluwadare et al. (2015), who criticized Nigerian engineering curricula for lagging behind global standards.
- **Insufficient Practical Exposure:** 70% of respondents highlighted limited hands-on practice due to large class sizes (average 60 students per session) and short lab sessions (1–2 hours weekly). This restricted their ability to master complex tasks, as practical learning is critical for CAD proficiency (Nyemba, 2023).

Additional barriers included unreliable electricity (reported by 55% of students) and limited internet access for online tutorials (48%), which hindered self-learning. These infrastructural challenges are particularly acute in Cross River State, where power outages are frequent.

Implications for Civil Engineering Practices

The moderate AutoCAD proficiency levels among civil engineering students in Cross River State have significant implications for advancing contemporary civil engineering practices in Nigeria, particularly in the context of Construction 4.0 and sustainable development. These implications are multifaceted, impacting employability, innovation, and infrastructural development.

- **Employability and Industry Readiness:** The predominance of moderate proficiency, with only 17.2% of students achieving high proficiency, suggests that many graduates may struggle to meet the demands of engineering firms adopting digital workflows. AutoCAD is a cornerstone of modern design processes, enabling precise drafting, structural analysis, and collaboration with stakeholders. Firms like Julius Berger Nigeria and local consultancies increasingly require proficiency in advanced AutoCAD features, such as 3D modeling and BIM integration, to design complex structures like bridges, high-rise buildings, and smart infrastructure. The current skill gap could limit graduates' competitiveness in the job market, as noted by Onwualu (2022), who emphasized that Nigerian engineers must align with global digital standards to secure roles in multinational projects.
- **Innovation in Design and Construction:** Proficiency in AutoCAD, particularly in advanced applications, is critical for driving innovation in civil engineering. For instance, 3D modeling enables engineers to simulate structural performance, optimize material use, and integrate sustainable design principles, such as low-carbon concrete or modular construction. The weak performance in 3D modeling (mean = 45.3) and parametric design (mean = 42.7) indicates that students are ill-equipped to contribute to innovative practices like green building design or resilient infrastructure, which are vital for addressing Nigeria's environmental challenges, such as flooding in Cross River State. Lotfy et al. (2021) argue that CAD proficiency enhances engineers' ability to incorporate eco-friendly materials and optimize designs, aligning with global sustainability goals like the UN's Sustainable Development Goals (SDGs).
- **Support for Infrastructural Development:** Cross River State, with its tourism-driven economy and ambitious projects like the Calabar-Ogoja Highway and urban renewal initiatives, requires a skilled workforce to deliver high-quality infrastructure. AutoCAD proficiency enables engineers

to produce accurate designs, reduce construction errors, and enhance project efficiency, as highlighted by Nyemba (2023). The current proficiency gaps, particularly in advanced features, could hinder the state's ability to execute complex projects efficiently. For example, 3D modeling is essential for visualizing infrastructure in flood-prone areas, ensuring designs account for hydrological and geotechnical factors. Without these skills, graduates may struggle to contribute to projects that address Nigeria's infrastructural deficits, estimated at \$3 trillion by the African Development Bank (2020).

- **Alignment with Construction 4.0:** The global shift toward Construction 4.0, characterized by digitalization, automation, and data-driven decision-making, underscores the need for advanced CAD skills. AutoCAD's integration with BIM and other digital tools facilitates collaborative project delivery, real-time simulations, and lifecycle management of infrastructure. The limited exposure to these advanced applications in Cross River State's institutions risks producing graduates disconnected from these trends. As Abubakar et al. (2015) note, Nigerian engineering education must prioritize digital tools to prepare students for Industry 4.0 demands.
- **Socioeconomic Implications:** Enhancing AutoCAD proficiency can have broader socioeconomic benefits. Skilled graduates can drive local innovation, reducing reliance on foreign expertise for major projects. This aligns with Nigeria's National Development Plan (2021–2025), which emphasizes local capacity building for infrastructural growth. Moreover, proficiency in AutoCAD can empower students to engage in entrepreneurial ventures, such as freelance design services or small-scale consultancies, fostering economic growth in Cross River State.

To address these implications, institutions must prioritize curriculum reform, invest in modern training facilities, and foster industry partnerships. For instance, integrating BIM-compatible AutoCAD modules can prepare students for collaborative design environments, while access to updated software can bridge the gap between academic training and industry needs. These steps are essential for equipping graduates to contribute to sustainable, innovative, and resilient civil engineering practices in Nigeria.

Conclusion

This study reveals that civil engineering students in Cross River State possess moderate AutoCAD proficiency, with strengths in 2D drafting but weaknesses in advanced 3D modeling and parametric design. While academic progression enhances skills, barriers like outdated software, inadequate facilities, and curricula misaligned with industry needs hinder progress. These gaps limit students' readiness to contribute to contemporary civil engineering practices, such as sustainable construction and digital project delivery. Addressing these challenges is crucial for preparing graduates to drive Nigeria's infrastructural development.

Recommendations

- **Curriculum Reform:** Integrate advanced AutoCAD modules (e.g., 3D modeling, BIM) into civil engineering curricula, aligning with Construction 4.0 standards.
- **Infrastructure Investment:** Establish well-equipped CAD laboratories with updated AutoCAD versions and high-performance computers.
- **Industry-Academia Collaboration:** Partner with engineering firms to provide internships and workshops, enhancing practical exposure.

- Faculty Development: Train lecturers in advanced AutoCAD applications to improve teaching quality.
- Subsidized Software Access: Negotiate with Autodesk for affordable student licenses to ensure access to current versions.

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