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Influence of Digital Tools on Students' Understanding of Architectural Drawings in Nigerian Universities

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ABSTRACT

This study investigated the influence of digital tools on undergraduate architecture students' comprehension of architectural drawings in Nigerian universities. The study employed a descriptive survey research design, involving a sample of 384 undergraduate students selected from five universities. The findings revealed that digital tools significantly enhance students' understanding of architectural drawings, visualization skills, and collaboration, with mean scores of 4.45, 4.55, and 4.30, respectively AutoCAD was the most commonly used digital tool (78.7%), followed by SketchUp (33.7%), and Revit (22.5%). However, the findings also revealed that students faced several challenges, including limited access to software (44.9%), insufficient training (39.3%), and poor internet connectivity (28.1%). There was no significant difference in the perceived impact of digital tools on learning outcomes between male and female students ($t(382) = 1.21$, $p = 0.23$), suggesting that digital tools are equally effective for both genders. However, , significant differences were found in digital tool adoption across universities ($F(4, 379) = 3.45$, $p = 0.008$), with the University of Lagos and Obafemi Awolowo University showing higher adoption rates. The study's findings imply that universities should invest in digital tools and supporting infrastructure, improve software accessibility, and provide regular training for both students and faculty to enhance architectural education. The study further recommends prioritizing the integration of digital technologies into teaching and learning, establishing well-equipped digital laboratories, and organizing workshops and training programmes to strengthen students' digital competencies and maximize the educational benefits of digital tools.

Keywords: Digital tools, architectural education, academic performance, AutoCAD, universities, students.

INTRODUCTION

The rapid advancement of digital technologies has transformed architectural education, shifting instructional practices from traditional manual drafting to digital design environments supported by Computer-Aided Design (CAD), Building Information Modelling (BIM), and other emerging technologies (Arayici, 2019). These digital tools have become integral to architectural training because they enhance drafting accuracy, visualization, collaboration, and design efficiency. Their adoption has also changed how students develop, interpret, and communicate architectural drawings, making digital competence an essential requirement for contemporary architectural education and professional practice.

Architectural drawings are fundamental to the teaching and practice of architecture, serving as the primary means of communicating design ideas and technical information throughout the design and construction process. Understanding architectural drawings requires students to possess strong spatial reasoning, visualization, and analytical skills. Consequently, integrating digital technologies into architectural education has attracted considerable scholarly attention, as these tools provide interactive learning environments that enhance students' comprehension of complex architectural concepts and improve learning outcomes (Al-Samarrai et al., 2022).

Previous studies have reported that digital technologies positively influence students' academic performance and design capabilities. Computer-Aided Design (CAD) applications have been shown to improve drafting speed, accuracy, and design quality, while Building Information Modelling (BIM) enhances interdisciplinary collaboration and students' understanding of building systems (Olukoya and Kuti, 2015; Shinkut et al., 2024). Similarly, emerging technologies such as Augmented Reality (AR) and Artificial Intelligence (AI) have demonstrated significant potential for improving visualization skills, spatial reasoning, creativity, and conceptual design development (Ali et al., 2022; Li et al., 2025). These developments suggest that digital technologies can significantly enhance students' understanding of architectural drawings and overall learning experiences.

Despite these advantages, the effective integration of digital tools into architectural education remains challenging, particularly within developing countries. Nigerian universities continue to face infrastructural constraints, including inadequate access to licensed software, insufficient computer

laboratories, unstable electricity supply, limited internet connectivity, and inadequate training opportunities for both students and lecturers (Akah, 2021; Al-Samarrai et al., 2022). These challenges may limit students' effective utilization of digital technologies and consequently reduce their potential impact on learning outcomes.

Although existing studies have examined digital technology adoption, CAD utilization, and technology-enhanced learning in architectural education, relatively few have specifically investigated how digital tools influence undergraduate students' understanding of architectural drawings in Nigerian universities. Most previous studies have emphasized technology adoption, software utilization, or design creativity, with limited attention given to students' comprehension of architectural drawings, visualization skills, collaborative learning, and the contextual challenges affecting effective technology integration. This gap highlights the need for empirical evidence to guide curriculum development and improve digital technology integration within architectural education.

Against this background, this study investigates the influence of digital tools on undergraduate architecture students' understanding of architectural drawings in Nigerian universities. Specifically, the study examines the digital tools commonly used by students, evaluates their influence on students' understanding of architectural drawings, visualization skills, and collaborative learning, and identifies the challenges affecting their effective utilization. The findings are expected to contribute to evidence-based curriculum development and provide practical recommendations for educators, policymakers, and professional bodies seeking to strengthen digital technology integration in architectural education (Kwon and Lee, 2020).

Research Objectives

The main objective of this study is to examine the influence of digital tools on undergraduate students' understanding of architectural drawings in Nigerian universities.

The specific objectives are to:

1. identify the digital tools commonly used by undergraduate architecture students in Nigerian universities;
2. examine the influence of digital tools on students' understanding of architectural drawings;
3. assess the influence of digital tools on students' visualization skills;
4. identify the challenges associated with the use of digital tools in architectural education; and
5. determine whether significant differences exist in the perceived influence of digital tools based on gender and university.

Research Hypotheses

The following null hypotheses were tested:

H_{01}: There is no significant difference in the perceived influence of digital tools on students' understanding of architectural drawings between male and female undergraduate architecture students.

H_{02}: There is no significant difference in the perceived influence of digital tools on undergraduate architecture students across selected Nigerian universities.

LITERATURE REVIEW

The increasing integration of digital technologies into architectural education has transformed the way students learn, interpret, and produce architectural drawings. Digital tools such as Computer-Aided Design (CAD), Building Information Modelling (BIM), Augmented Reality (AR), and Artificial Intelligence (AI)-supported applications have enhanced visualization, drafting accuracy, collaboration, and design efficiency, making them indispensable in contemporary architectural training. Their adoption is particularly important in architecture because students must develop strong spatial reasoning and graphical communication skills to interpret complex architectural drawings and communicate design ideas effectively (Olukoya and Kuti, 2015; Ali et al., 2022).

This study is anchored on the Technology Acceptance Model (TAM) developed by Davis (1989), which explains technology adoption through two key constructs: perceived usefulness and perceived ease of use. The model suggests that students are more likely to adopt digital tools when they perceive them as useful in improving learning outcomes and when they consider the tools easy to operate. Within architectural education, TAM provides an appropriate framework for explaining how students' perceptions influence their willingness to use digital technologies for interpreting architectural drawings, improving visualization skills, and enhancing academic performance (Li and Xu, 2025).

Empirical evidence demonstrates that digital tools significantly improve architectural education. CAD applications have consistently been associated with improved drawing accuracy, productivity, and design quality. Olukoya Obafemi and Kuti (2015) reported that CAD significantly improved students' speed and precision in producing architectural drawings, while Oladumiye (2023) found that students exposed to CAD-based instruction achieved significantly higher performance in technical drawing than those relying primarily on manual drafting. Similarly, Akah (2021) observed that approximately 88.6% of architecture students preferred CAD over manual drafting because of its efficiency, flexibility, and accuracy. Beyond CAD, emerging digital technologies have further enhanced architectural learning. Building Information Modelling (BIM) has become an important educational tool because it integrates architectural, structural, and construction information into a single intelligent model, enabling students to understand building systems more comprehensively while improving interdisciplinary collaboration (Shinkut et al., 2024). Likewise, Augmented Reality (AR) has demonstrated considerable potential in architectural and engineering education by transforming two-dimensional drawings into interactive three-dimensional visualizations. Ali et al. (2022) reported that AR significantly improved students' understanding of complex geometries, spatial relationships, and visualization skills, while also increasing learner engagement and motivation.

Recent developments in Artificial Intelligence have introduced new possibilities for architectural education (As et al., 2018; Eren and Yılmaz, 2022).). AI-powered design applications can generate conceptual design alternatives, support design exploration, and improve decision-making during the early

Table 1: Distribution of Sample Size Across Universities.

University	Population	Sample Size
University of Lagos	2,000	77
Obafemi Awolowo University	1,800	69
University of Nigeria, Nsukka	2,500	96
Ahmadu Bello University	1,500	58
Federal University of Technology, Minna	2,200	84
Total	10,000	384

stages of architectural design (As at al., 2018; Alliso and Bala, 2022; Li et al., 2025). Similarly, hybrid digital tools that combine conventional design approaches with advanced digital technologies have been found to promote creativity, critical thinking, and iterative design exploration, thereby enhancing students' problem-solving abilities (Eren and Yılmaz, 2022). These findings suggest that digital technologies extend beyond drafting functions to support broader aspects of architectural learning and design development.

Despite these educational benefits, the adoption of digital tools within Nigerian universities continues to face several challenges. Inadequate access to licensed software, insufficient computer facilities, unstable electricity supply, poor internet connectivity, and limited technical support remain significant barriers to effective digital learning (Akah, 2021; Oladumiye, 2023). In addition, insufficient training often limits students' ability to utilize available technologies effectively, reducing the potential educational benefits of digital tools.

Although previous studies have established the importance of CAD, BIM, AR, AI, and other digital technologies in architectural education, most have focused on software adoption, academic performance, or design creativity. Comparatively little attention has been given to how these technologies specifically influence undergraduate students' understanding of architectural drawings, particularly within Nigerian universities where infrastructural limitations and unequal access to digital resources may affect learning outcomes. Furthermore, few studies have simultaneously examined students' understanding of architectural drawings, visualization skills, collaborative learning, and the contextual challenges influencing digital tool utilization.

This study addresses these gaps by examining the influence of digital tools on undergraduate architecture students' understanding of architectural drawings in Nigerian universities. Specifically, it investigates the contribution of digital tools to students' comprehension of architectural drawings, visualization skills, and collaborative learning while identifying the institutional and technological challenges affecting their effective utilization. The findings are expected to provide empirical evidence that will support curriculum improvement and strengthen the integration of digital technologies into architectural education.

MATERIALS AND METHODS

Research Design

This study adopted a descriptive survey research design to investigate the influence of digital tools on undergraduate architecture students' understanding of architectural drawings in selected Nigerian universities. The design was considered appropriate because it enabled the collection of quantitative data on students' perceptions, digital tool usage, and learning outcomes without manipulating the study variables (Nworgu, 2006; Creswell, 2014).

Study Population and Sample

The study population comprised undergraduate architecture students enrolled in accredited Nigerian universities offering architecture programmes. Using Yamane's (1967) sample size determination formula, a sample of 384 students was obtained from an estimated population of 10,000 students. Participants were selected from five universities: the University of Lagos, Obafemi Awolowo University, University of Nigeria, Nsukka, Ahmadu Bello University, and the Federal University of Technology, Minna. The universities were selected based on geographical representation, accreditation status, and the availability of undergraduate architecture programmes. Students were selected using simple random sampling.

Table 1 presents the distribution of the study sample across the five selected Nigerian universities. Of the estimated population of 10,000 undergraduate architecture students, a sample of 384 respondents was proportionately allocated according to the population size of each university. The University of Nigeria, Nsukka contributed the largest sample (96), while Ahmadu Bello University contributed the smallest sample (58).

Instrument for Data Collection

Data were collected using a structured questionnaire consisting of three sections. Section A collected respondents' demographic information, Section B examined digital tool adoption and usage, while Section C assessed the perceived influence of digital tools on students' understanding of architectural drawings, visualization skills, collaborative learning, and the challenges associated with digital tool utilization. Responses were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Validity and Reliability of the Instrument

The questionnaire was validated by experts in architecture and educational measurement to ensure content validity. Reliability was established using Cronbach's alpha coefficient. The overall reliability coefficient was 0.85, indicating high internal consistency (Hair et al., 2010; Creswell, 2014). The reliability coefficients for the study constructs were 0.82 for Digital Tool Adoption, 0.78 for Visualization Skills, 0.81 for Challenges Associated with Digital Tool Utilization, and 0.84 for Perceived Learning Outcomes, confirming that the instrument was

Table 2: Demographic characteristics of respondents.

Demographic Variabl	Frequency	Percentage (%)
Gender		
Male	230	64.6
Female	126	35.4
Level of Study		
100 Level	80	22.5
200 Level	90	25.3
300 Level	100	28.1
400 Level	86	24.2
University		
University of Lagos	70	19.7
Obafemi Awolowo University	65	18.3
University of Nigeria, Nsukka	90	25.3
Ahmadu Bello University	53	14.9
Federal University of Technology, Minna	78	21.9

Table 3: Response Rate by University.

University	Sample Size	Respondents	Response Rate (%)
University of Lagos	77	70	90.9
Obafemi Awolowo University	69	65	94.2
University of Nigeria, Nsukka	96	90	93.8
Ahmadu Bello University	58	53	91.4
Federal University of Technology, Minna	84	78	92.9
Total	384	356	92.7

suitable for data collection.

Data Collection Procedure

Following approval from the participating universities, the questionnaires were administered directly to undergraduate architecture students during scheduled lecture periods. Participation was voluntary, and completed questionnaires were retrieved immediately after completion to maximize the response rate.

Data Analysis

The collected data were analysed using the Statistical Package for the Social Sciences (SPSS) version 27 (Pallant, 2013). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' demographic characteristics and digital tool usage patterns. An independent samples t-test was employed to examine gender differences in the perceived influence of digital tools, while one-way Analysis of Variance (ANOVA) was used to determine differences among students from the selected universities. Statistical significance was determined at the 0.05 level.

Ethical Considerations

Ethical approval was obtained from the appropriate institutional ethics committee before data collection. Participation was voluntary, and informed consent was obtained from all respondents. Participants were assured of anonymity and confidentiality, and all data were used solely for research purposes.

RESULTS

Table 2 presents the demographic characteristics of the respondents. Male students constituted 64.6% of the sample, while females accounted for 35.4%. The respondents were fairly distributed across the four academic levels, with 300 Level students forming the largest proportion (28.1%). Regarding institutional representation, the University of Nigeria, Nsukka accounted for the highest proportion of respondents (25.3%), followed by the Federal University of Technology, Minna (21.9%), the University of Lagos (19.7%), Obafemi Awolowo University (18.3%), and Ahmadu Bello University (14.9%).

Table 3 presents the response rate for the study. Of the 384 questionnaires distributed, 356 were completed and returned, representing an overall response rate of 92.7%. Obafemi Awolowo University recorded the highest response rate (94.2%), while the University of Lagos recorded the lowest (90.9%). The high response rate indicates adequate participation and provides confidence in the reliability of the data used for analysis.

Research Objective 1: Identify the digital tools commonly used by undergraduate architecture students in Nigerian universities

Table 4 presents the digital tools commonly used by undergraduate architecture students in the selected Nigerian universities. AutoCAD was the most widely used software, with 280 respondents (78.7%), followed by SketchUp (33.7%), Revit (22.5%), Adobe Creative Suite (16.9%), and other digital applications (5.6%). The findings indicate that AutoCAD remains the dominant software for architectural drawing

Table 4: Digital Tools Used by Students for Architectural Drawings.

Digital Tool	Frequency	Percentage (%)
AutoCAD	280	78.7
SketchUp	120	33.7
Revit	80	22.5
Adobe Creative Suite	60	16.9
Other	20	5.6

Table 5: Influence of Digital Tools on Students' Understanding of Architectural Drawings.

Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Mean	Std. Dev.
Digital tools improve my understanding of architectural drawings	210 (59.0)	120 (33.7)	20 (5.6)	4 (1.1)	2 (0.6)	4.45	0.73
Digital tools enhance my visualization of architectural designs	240 (67.4)	100 (28.1)	10 (2.8)	4 (1.1)	2 (0.6)	4.55	0.67
Digital tools facilitate collaboration with peers on design projects	180 (50.6)	140 (39.3)	30 (8.4)	|4 (1.1)	2 (0.6)	4.30	0.78

Table 6: Influence of Digital Tools on Academic Performance.

Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Mean	Std. Dev.
Digital tools improve my academic performance in architectural drawings	200 (56.2)	130 (36.5)	20 (5.6)	4 (1.1)	2 (0.6)	4.40	0.75
Digital tools enhance my understanding of complex design concepts	220 (61.8)	110 (30.9)	20 (5.6)	4 (1.1)	2 (0.6)	4.50	0.70

instruction in Nigerian universities, while the relatively lower utilisation of BIM-based applications such as Revit suggests limited exposure to more advanced digital technologies.

Research Objective 2: Examine the influence of digital tools on students' understanding of architectural drawings

The findings presented in Table 5 reveal that respondents generally perceived digital tools as enhancing their understanding of architectural drawings. The statement *"Digital tools enhance my visualization of architectural designs"* recorded the highest mean score (M = 4.55, SD = 0.67), followed by *"Digital tools improve my understanding of architectural drawings"* (M = 4.45, SD = 0.73) and *"Digital tools facilitate collaboration with peers"* (M = 4.30, SD = 0.78). These mean values, all above the criterion mean of 3.00, indicate strong agreement among respondents regarding the positive contribution of digital technologies to architectural learning.

Research Objective 3: Assess the influence of digital tools on students' academic performance and visualization skills

Table 6 indicates that respondents perceived digital tools as improving their academic performance and comprehension of architectural concepts. The statement *"Digital tools enhance my understanding of complex design concepts"* recorded a mean score of 4.50 (SD = 0.70), while *"Digital tools improve my academic performance in architectural drawings"* recorded a mean of 4.40 (SD = 0.75). These findings suggest that digital technologies contribute positively to students' learning outcomes in architectural education.

Research Objective 4: Identify the challenges associated with the use of digital tools

The findings in Table 7 show that the major challenge affecting students' use of digital tools was limited access to software (44.9%), followed by insufficient training (39.3%), poor internet connectivity (28.1%), and hardware limitations (22.5%). These findings indicate that infrastructural and technical constraints continue to hinder the effective integration of digital technologies into architectural education.

Research Objective 5: Determine whether digital tool usage differs across universities

Table 8 shows variations in digital tool usage among the selected universities. The University of Lagos recorded the highest utilisation of AutoCAD (85.7%) and SketchUp (40.0%), while the University of Nigeria, Nsukka reported relatively

Table 7: Challenges Faced by Students in Using Digital Tools for Architectural Drawings.

Challenge	Frequency	Percentage (%)
Limited access to software	160	44.9
Insufficient training on the software	140	39.3
Poor internet connectivity	100	28.1
Hardware limitations	80	22.5
Other	20	5.6

Table 8: University-wise Comparison of Digital Tool Usage.

University	AutoCAD (%)	SketchUp (%)	Revit (%)	Adobe Creative Suite (%)
University of Lagos	85.7	40.0	25.7	20.0
Obafemi Awolowo University	80.0	30.8	20.0	15.4
University of Nigeria, Nsukka	77.8	35.6	24.4	17.8
Ahmadu Bello University	75.5	28.3	18.9	13.2
Federal University of Technology, Minna	82.1	32.1	21.4	16.7

Table 9: t-test analysis: Influence of Gender on Perceived Impact of Digital Tools.

Gender	n	Mean	SD	t-value	p-value
Male	210	4.2	0.8	1.21	0.23
Female	174	4.1	0.9		

Table 10: ANOVA analysis of digital tool adoption across universities.

University	n	Mean	SD	F-value	p-value
University of Lagos	80	4.5	0.7	3.45	0.008
Obafemi Awolowo University	75	4.8	0.8		
University of Nigeria Nsukka	78	4.1	0.7		
Ahmadu Bello University	76	3.9	0.8		
Federal University of Technology Minna	75	3.8	0.9		

higher use of Revit (24.4%). Ahmadu Bello University recorded the lowest usage across most of the digital applications considered. These findings indicate institutional differences in the availability and utilisation of digital technologies.

Hypothesis One

There is no significant difference in the perceived influence of digital tools on students' understanding of architectural drawings between male and female undergraduate architecture students.

Decision Rule

Reject H_0 if $p < 0.05$.

Table 9 presents the independent samples t-test comparing male and female students' perceptions of the influence of digital tools. Male students recorded a mean score of 4.20 (SD = 0.80), while female students recorded a mean score of 4.10 (SD = 0.90). The analysis produced t(382) = 1.21, p = 0.23. Since p > 0.05, the null hypothesis was not rejected. Therefore, there is no statistically significant difference in the perceived influence of digital tools on understanding architectural drawings between male and female students.

Hypothesis Two

There is no significant difference in digital tool adoption among undergraduate architecture students across selected Nigerian universities.

The one-way ANOVA presented in Table 10 revealed a statistically significant difference in digital tool adoption among the selected universities F(4, 379) = 3.45, p = 0.008. Since the probability value is less than the 0.05 level of significance, the null hypothesis was rejected. This indicates that students' adoption of digital tools differs significantly across the participating universities.

Post Hoc Analysis

Note: NS = Not significant

The Tukey HSD post hoc analysis identified the specific universities responsible for the observed differences. The University of Lagos (Table 11) recorded significantly higher

Table 11: Post-hoc test results (Tukey's HSD).

University comparison	Mean difference	p-value
University of Lagos vs. Ahmadu Bello University	0.6	0.01
University of Lagos vs. Federal University of Technology Minna	0.7	0.005
Other comparisons		NS

digital tool adoption than Ahmadu Bello University (Mean Difference = 0.60, p = 0.01) and the Federal University of Technology, Minna (Mean Difference = 0.70, p = 0.005). No statistically significant differences were observed among the remaining university comparisons.

DISCUSSION OF FINDINGS

This study examined the influence of digital tools on undergraduate architecture students' understanding of architectural drawings in selected Nigerian universities. The findings demonstrate that digital tools positively influence students' understanding of architectural drawings, visualization skills, and collaborative learning. Respondents reported high levels of agreement that digital technologies improved their understanding of architectural drawings (M = 4.45), enhanced visualization of architectural designs (M = 4.55), and facilitated collaboration on design projects (M = 4.30). These findings suggest that digital technologies play an important role in improving students' learning experiences by supporting spatial reasoning, graphical communication, and interactive learning. The findings support the Technology Acceptance Model (TAM) proposed by Davis (1989), which posits that users are more likely to adopt technology when they perceive it as useful and easy to use. The positive perceptions expressed by the respondents indicate that digital tools are regarded as valuable learning resources capable of improving architectural drawing comprehension and academic performance. This finding is consistent with Ali et al. (2022), who reported that digital visualization technologies improved students' understanding of complex architectural and engineering drawings. Similarly, Olukoya Obafemi and Kuti (2015) found that CAD applications significantly enhanced students' drafting accuracy and design efficiency, while Adeyemi and Oluwatayo (2019) reported improved learning outcomes following the integration of digital technologies into architectural education (Eren and Yılmaz, 2022).

The study further revealed that AutoCAD remains the most widely used digital application among undergraduate architecture students, followed by SketchUp and Revit. The dominance of AutoCAD reflects its continued importance as the foundational software for architectural drafting in Nigerian universities. This finding agrees with Kwon and Lee (2020), who observed that AutoCAD remains the most frequently adopted software in architectural education because of its versatility and ease of application. However, the comparatively low utilization of Revit suggests that Building Information Modelling (BIM) technologies have not yet been fully integrated into many architecture programmes. This finding indicates the need for curriculum updates that expose students to more advanced digital design platforms used in contemporary architectural practice.

Despite the positive influence of digital tools, the study identified several barriers to their effective utilization. Limited access to licensed software, inadequate training opportunities, and poor internet connectivity were the most frequently reported challenges. These findings corroborate those of Al-Khaldi (2018), who identified inadequate infrastructure, software accessibility, and insufficient technical support as major constraints to technology integration in architectural education. The persistence of these challenges suggests that improvements in technological infrastructure alone may not be sufficient without complementary investments in capacity building and institutional support.

The hypothesis testing further revealed that gender did not significantly influence students' perceptions of the impact of digital tools on learning outcomes (Kwon and Lee, 2020). This finding suggests that male and female students benefit similarly from the use of digital technologies, provided that equal learning opportunities and access to digital resources are available. This supports the view that technology-enhanced learning environments can promote inclusive educational experiences irrespective of gender.

Conversely, the study found significant differences in digital tool adoption across the selected universities. The post hoc analysis showed that students from the University of Lagos demonstrated significantly higher levels of digital tool adoption than those from Ahmadu Bello University and the Federal University of Technology, Minna. These institutional differences may reflect variations in digital infrastructure, curriculum implementation, software availability, faculty expertise, and institutional investment in educational technologies. The findings therefore suggest that institutional support plays a critical role in determining the effectiveness of digital technology integration within architectural education.

Overall, the findings demonstrate that while digital technologies substantially enhance students' understanding of architectural drawings and improve learning outcomes, maximizing these benefits requires adequate infrastructure, software accessibility, institutional support, and continuous training for both students and lecturers.

CONCLUSION

This study investigated the influence of digital tools on undergraduate architecture students' understanding of architectural drawings in selected Nigerian universities. The findings demonstrate that digital technologies significantly enhance students' understanding of architectural drawings, improve visualization skills, facilitate collaborative learning, and support better academic performance. AutoCAD remains the most widely used digital application, although the adoption of more advanced technologies such as Revit remains relatively limited.

The study also identified several challenges that constrain the effective integration of digital technologies into architectural education, particularly limited software accessibility, inadequate training opportunities, and poor internet connectivity. Furthermore, while students' perceptions of digital tools did not differ significantly by gender, significant institutional differences in digital tool adoption were observed across the participating universities, highlighting the influence of institutional resources and support on technology adoption.
Overall, the findings demonstrate that digital technologies have become indispensable components of contemporary architectural education. However, their educational benefits can only be fully realized when universities provide adequate digital infrastructure, improve access to industry-standard software, and promote continuous capacity building for both students and academic staff.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Universities should invest in modern digital infrastructure, including well-equipped computer laboratories, reliable internet connectivity, and licensed architectural software.
2. Architecture curricula should be regularly updated to incorporate emerging digital technologies such as Building Information Modelling (BIM), Artificial Intelligence (AI), and Augmented Reality (AR) alongside conventional CAD applications.
3. Regular workshops, practical training programmes, and professional development initiatives should be organized for both students and lecturers to strengthen digital competencies.
4.Universities should establish partnerships with software developers and professional architectural organizations to improve students' access to industry-standard digital tools through educational licensing programmes.
5.Institutions with lower levels of digital tool adoption should benchmark successful practices from universities demonstrating higher levels of technology integration to improve teaching and learning outcomes.

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