

Improving Students' Technical Drawing Skills with Digital Tools (AutoCAD) in Technical Colleges, Lagos State

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Abstract

The use of digital tools in technical education has transformed the teaching and learning of technical drawing, a critical skill in engineering and vocational fields. This study investigates the impact of digital tools on the technical drawing skills of students across varying proficiency levels in technical colleges in Lagos State, Nigeria. The research involved 90 students from selected government technical colleges, including Federal Science and Technical College (Yaba) and Government Technical College (Ikorodu). A quasi-experimental design with a single-group pre-test/post-test approach was employed to assess improvements in technical drawing skills, including orthographic projection, isometric drawing, spatial visualization, and precision. Findings revealed significant enhancements in technical drawing skills among students with low and medium proficiency levels after using digital tools such as Computer-Aided Design (AutoCAD) software and interactive digital learning platforms. These results underscore the positive role of digital tools in enhancing technical drawing education. The study results have implications for the creation of new, technology-enhanced technical drawing curriculums for technical schools. Future studies can be performed on creating personalized digital tools and their long-term impacts on the technical drawing abilities and employability of students.

Keywords: Technical drawing, digital tools, AutoCAD, spatial visualization, technical education, digital learning, vocational training

Introduction

Computer technology has revolutionized the teaching and learning of technical drawing, a staple of engineering, architecture, and vocational education. Computer-aided design (CAD) software has evolved from basic drafting software since the 1980s into sophisticated software enabling precise, three-dimensional models of technical designs (Berselli et al., 2020). This period marked the emergence of digital tools as a transformative force in technical education, shifting traditional manual drafting to digital platforms. Researchers describe this shift as the rise of "digital technical drawing," representing a transition from manual to computer-based methods that enhance accuracy and efficiency (Muse, 2024).

The digital tools that have been accepted into technical colleges include AutoCAD, SolidWorks and interactive digital leaning platforms because they serve as a bridge between the traditional drafting styles and contemporary requirements of technology. Such tools would be in line with the demands of the industry in Lagos State, Nigeria, where the construction, manufacturing, and engineering sectors emerge as prize-winning industries (Muoleeh, 2025). However, criticisms of digital technical drawing exist. It is argued that it does not provide the feel of the drafting tools or the act of drawing on paper or it can be expensive in terms of software and hardware requirements (Metraglia, 2015). Moreover, a steep learning curve related to complex CAD software may be the case when it comes to students having little prior exposure (Xie, 2024). Nonetheless, the challenges above are superseded by the considerable benefits of the digital tools, including precision, ease of editing, and simulation of the real-world applications, which cannot be underestimated in the context of current technical schools (Monarch Innovation, 2023).

Digital tools have transformed technical drawing by enabling students to create precise orthographic projections, isometric drawings, and 3D models, fostering skills critical for vocational and industrial applications. A case study from Lagos State's technical colleges, highlights the practical impact of digital tools on students' technical drawing skills. Analysing data from these colleges, this study demonstrates how digital tools enhance spatial visualization, accuracy, and efficiency (Dagman & Wärmefjord, 2022). The growing demand for digitally skilled technicians in Nigeria's job market, particularly in technology-driven sectors, underscores the relevance of this transition. For instance, industries in Lagos

increasingly seek graduates proficient in CAD software, reflecting a broader trend where over 60% of high-paying technical jobs require digital drafting skills (Samah et al., 2016).

Technical drawing facilitated by digital tools is defined as the use of information technology to create, edit, and present technical designs (Ling & Gao, 2025). Software like AutoCAD, Revit, Computer-Aided Drawing Learning Tools (CADLT) give digital drafting tables, new CAD rulers, and a 3D modeling stack, and parallel older instruments though they offer advanced features (Lee & Cheng, 2021). Such tools enable the students to work in a systematic and free-of-error workplace, isolating the messiness of free manual drafting. Nevertheless, certain teachers believe that computer aids might be less tactile in their results as compared to hand-based drafting, which can hinder the basic knowledge of students when it comes to drawing fundamentals (Metraglia, 2015). Nevertheless, digital tools facilitate the process of scaling, copying and manipulating the designs, thus, becoming critical in training students to meet the industry requirements (Aboalgasm & Ward, 2014).

Information technology provides a link between the old technical drawing and the contemporary training in vocations so that students can create professional works in drawing. This is the case in the technical colleges in Lagos State where access to modern equipment may be scarce, and digital platforms present the opportunity to improve the results of educational activities and make them correspond to the realities of the industrial field (Meng et al., 2025). The case study examines the role of digital media, which include computer-aided design software, interactive learning platforms in enhancing students technical drawing skills that are more effective in resolving, such issues as visualization difficulties and the emergence of competencies that support the requirements of the technical workforce in growing Nigeria.

Objective of the Study

The objective of this study was to determine the impact of digital tools on the technical drawing skills of students with varying levels of academic performance in technical colleges in Lagos State, Nigeria. The specific objectives are:

1. to evaluate the baseline technical drawing skills of low-performing and average students, focusing on orthographic projection, isometric drawing, spatial visualization, and precision.
2. to measure the progress (if any) in technical drawing skills among students in different ability groups after using AutoCAD.

3. to assess student motivation and engagement when creating technical drawings with digital tools.

Literature Review

The Role of Information Technology in Technical Drawing Education

Experts in the spheres of engineering, education, and technologies debate the ways of integrating the digital tools in technical drawing as an essential part of vocational and engineering training (Berselli et al., 2020). Technical drawing has changed due to the development of digital technologies, which advanced new methods and instruments of technical drawing bringing accuracy, visualization and efficiency (Monarch Innovation, 2023). Technical drawing education has been broadened to include fields, like computer-aided design (CAD), 3D modeling, virtual reality and interactive learning platforms whereby students can draw complex designs that fit the requirements of the industry (Kravchenko & Green, 2024). However, the application of digital tools has allowed enhancing the established methods of drafting (including a manual orthographic and isometric drawing), resulting in the emergence of the new teaching approaches and skillsets that are valuable in the industries of present-day engineering and construction (Dagman & Warmefjord, 2022).

Digital technical drawing is software-based form of technical drawing and editing and visualizing the technical designs do provide the unavailable set of tools in traditional drafting (ScienceDirect, n.d.). They consist of computer assisted design programs such as CAD software, e.g., AutoCAD, SolidWorks, and Revit, carrying floor-planning virtual drafting boards and precise measurement tools, and 3-dimensional modelling. With the help of graphics tablets and styluses, students are in a position to emulate hand-drawn styles with digital precision as they maintain the experience of working with traditional drafting tools and possess new capabilities, such as, scaling, rotation, and error correction (Berselli et al., 2020). Computer-based tools are more accessible in that students can study technical drawing through interaction with computers, even in low resources environments (Muoleeh, 2025). The tools respond sensitively to input provided by the user and they will allow the students to change line weights and widths as well as dimensions of line segment extremely accurately and this is essential to creating professional standard drawings. Mastery of this type of software prepares students to work in other industries such as construction, manufacturing, and engineering that constantly require the skills of digital drafting (Muoleeh, 2025).

The digital tools used in the teaching of technical drawing have made the learning resources more readily available and strengthened the development of skills. The storage and sharing of the technical drawing could be done with the use of digital platforms, which helps students and instructors cooperate and revise the drawings (Kravchenko & Green, 2024). In addition to the technical advantages, the digital equipment will improve spatial perception of students, problem-solving, and accuracy that are necessary during the vocational training (Dagman & Warmefjord, 2022). Where challenges of availability of modern equipment hit technical colleges, the lack of such equipment will be provided by digital tools in Lagos State since they are cost-effective (Muoleeh, 2025). They also introduce critical thinking and innovation as well as allow the student to experiment its use and simulate real-life applications and more complex designs (Monarch Innovation, 2023). Studies indicate that the use of digital tools can not only enhance technical trainings but also transform students' visions of technical drawing as a transferable, industry-specific capability (Kravchenko & Green, 2024).

The merging of digital technology in technical drawing teaching and learning has serious consequences to curriculum development in Lagos State technical colleges. Digital tools allow aligning educational practice with industry demands, getting the students ready to enter the sphere of technical work in Nigeria, especially in such spheres as construction and manufacturing (Muoleeh, 2025). Nevertheless, a lack of infrastructure, expensive software, and a necessity to educate teachers should be overcome to optimize the effect of these factors (Metraglia, 2015; Muoleeh, 2025). The analysis of the role of digital tools in educating technical drawing has a practical influence on improving teaching approaches and making sure that students would be prepared with skills required to succeed in contemporary vocational professions.

Types of Digital Tools and Software in Technical Drawing Education

Digital tools in technical drawing education encompass 2D and 3D design applications, each serving distinct purposes in vocational and engineering training. 2D technical drawing process is done by using flat drawings, which are generally orthographic projections, and are shown on the electronic screen, whereas in the 3D technical drawing process, the virtual model is projected onto the screen that simulates the actual object (Berselli et al., 2020). With 2D drawing, the trainees utilise the tools, such as a stylus or mouse, in order to draw exact lines and figures on the interface of software, which is similar to a traditional drafting that uses pencils and pens on a sheet of paper (Kravchenko & Green,

2024). The designs that come out, including Floor plans or sectional views, are displayed on screen with very good accuracy. Alternatively, 3D technical drawing is a process developed with the help of software that creates a virtual reality (VR) image or a 3D model, which enables students to place and manipulate objects as they would by looking through a computer window (Monarch Innovation, 2023).

Two-dimensional technical drawing normally uses raster graphics to build the detail line work, including plans and elevations, whereas three-dimensional graphic drawing uses vector graphics to build projective models, including architectural or mechanical perspective designs (ScienceDirect, n.d.). By using such relevant software as AutoCAD, SolidWorks, Revit, and others, it is possible to control the visual parameters involved (line weight, scaling, symmetry, and geometry of shapes such as a circle, ellipse, and polygon) accurately and create mathematically accurate results (Dagman & Warmfjord, 2022). Such features as error correction, undo features (the ability to undo most actions), and grid systems make drafting more accurate, but potentially less tactile/immediate in their execution (Metraglia, 2015). Platforms that run on browsers, notably Computer-Aided Drawing Learning Tools (CADLT) provide easily accessible user interface which enable students in resource limited environments, such as the technical colleges in Lagos State to practice technical drawing interactively (Muoleeh, 2025).

The software or features used define what will be output, whether detailed 2D blueprints or realistic 3D render, just like what could be done the old way using different modes of drawing such as orthographic or isometric projections. Advanced CAD programs streamline the drafting process and broaden the technical skills of students to allow them to develop drafts professionally and to the standards stipulated in the industry (Monarch Innovation, 2023). In Lagos State, where technical colleges prepare students for industries such as construction and manufacturing, digital tools foster skills in spatial visualization, precision, and problem-solving (Muoleeh, 2025). These tools augment traditional drafting by offering new capabilities, such as real-time collaboration and simulation, which transform students' understanding of technical drawing as a dynamic, industry-relevant skill (Kravchenko & Green, 2024).

The Essence of Digital Technical Drawing and Its Educational Context

Digital technical drawing standardizes traditional drawing technologies, including manual orthographic and isometric drawing, through the application of powerful software

tools producing well-precise, industry-standard design. The method uses the power of graphics programs with their extensive arsenal of capabilities such as virtual drawing boards, measurement devices, and 3D modeling (Berselli et al., 2020). Computer applications (AutoCAD, SolidWork, Revit, etc.) have become the norm in technical studies and allow learners to create highly qualified technical documents (Monarch Innovation, 2023). There are disadvantages to these tools, however, as they demand constant updates to be able to feature such attributes as real-time collaboration and advanced simulation that allow achieving the most favourable educational results (Kravchenko & Green, 2024).

AutoCAD and Computer-Aided Drawing Learning Tools (CADLT) are digital tools in the learning setting; it is an efficient methodology in teaching technical drawing in vocational and education programmes. The sort of skills promoted using these tools includes spatial visualization, accuracy, and problem-solving, which are highly required by students in technical colleges in Lagos State (Muoleeh, 2025). Modeling reality, digital tools help fill the gap between theoretical drafting and the demands of the industry as they introduce students to the process of drawing and creating precise 2D blueprints and 3D recognizable blueprints (Dagman & Warmefjord, 2022). Nevertheless, the provision cost of software, infrastructure, and the training of teachers remain issues of this technology, especially in underprivileged environments such as a state like Lagos (Muoleeh, 2025; Metraglia, 2015).

Digital technical drawing tools enhance technical competency, beyond that however, they also change the learning experience creating active participation and new innovations. They provide learners with the freedom to explore complicated designs, make adjustments in record time, and work in groups, and they are getting ready to work in the booming construction, manufacturing, and engineering fields in Nigeria (Monarch Innovation, 2023; Muoleeh, 2025). Being an inevitable constituent of the contemporary technical education, these tools have to be constantly incorporated in the curriculum to meet the industry standards and overcome local problems in order to provide the students with skills necessary to succeed in the vocational environment.

Methods

Design

This study uses a quasi-experimental single-group pre-test/post-test design to assess AutoCAD's impact on technical drawing skills in Lagos State's technical colleges. This approach measures skill improvement without random group assignment, suitable for

educational settings. The independent variable is AutoCAD, and the dependent variable is students' technical drawing test scores, evaluating orthographic projection, isometric drawing, spatial visualization, and precision. This design captures AutoCAD's effect on skill development and motivation in resource-constrained contexts.

Sample

A total of 90 students who represented two technical colleges in Lagos State, Nigeria, Federal Science and Technical College (Yaba) and Government Technical College (Ikorodu) were selected to form the sample. The sample was split into two groups which comprised of students who had low and moderate general achievements (low-achiever group, n=45; moderate-achiever group, n=45) following their average grade point achieved in technical drawing courses the previous semester. Participation was enabled by college administrators and the participants were chosen by the instructors in order to have balanced representation. The sample included students aged 17–19 with similar baseline AutoCAD skills, determined by a brief online proficiency test.

Research Tools

Course instructors evaluated technical drawings from pre- and post-test assignments using AutoCAD. Assessment criteria focused on orthographic projection, isometric drawing, spatial visualization, and precision. Specific parameters included accuracy of lines and measurements, adherence to drafting standards (e.g., scaling, symmetry), clarity of 3D models, and effective use of AutoCAD tools. A motivation survey assessed students' engagement with digital tools, using Likert-scale questions adapted from prior CAD education studies. These tools ensured reliable measurement of skill improvement and motivation in a vocational context.

Procedure

Before the course, students completed a pre-test, creating a 2D technical drawing (e.g., orthographic projection) using a laptop and AutoCAD within two and a half hours. Students were provided with a reference blueprint or technical sketch to replicate. The resulting drawings were taken as pre-test results, measuring baseline abilities in precision and spatial visualization. After the pre-test, students underwent training on how to use AutoCAD to produce technical drawings with a focus on orthographic projections, isometric drawings, and 3D modeling.

Data Analysis

Statistical analysis was conducted to determine mean scores for technical drawing tests. The study has one independent variable (AutoCAD use) and four dependent variables: orthographic projection, isometric drawing, spatial visualization, and precision. SPSS Statistics version 27 was used to calculate mean values and standard deviations for pre- and post-test data. An independent statistician performed the analysis to ensure reliability and acceptable standard deviation intervals. A paired t-test assessed skill improvement, and survey responses on motivation were analysed descriptively to evaluate engagement.

Limitations

The study faced limitations due to time and funding constraints. Pre- and post-tests used the same AutoCAD software, potentially inflating skill improvement due to familiarity after the 12-lesson training course. No control group without AutoCAD experience was included, limiting comparisons. The assessment procedure was not tailored for students with varying AutoCAD proficiency levels. These limitations will be addressed in future studies by incorporating control groups and refined assessment tools to enhance generalizability.

Ethical Standards

The study was approved by the administration. All participants provided written informed consent, and the study adhered to ethical standards, ensuring confidentiality and voluntary participation.

Results and Discussion

Analysis of Technical Drawing Skills before the Training Programme

The mean scores of the pre-test performance on the technical drawing (as shown in table 1) was obtained on the sample of the 90 students in the Federal Science and Technical College (Yaba) and government technical College (Ikorodu). Descriptive statistics indicate that there are differences between mean scores of low-performing (n=45) and moderate-performing (n=45) groups. The low-performing group obtained a mean of 7.02 in orthographic projection as compared to the moderate-performing group which obtained 9.12. In the case of isometric drawing, means were 6.73 and 9.01 respectively. In spatial visualization, the mean of the low-performing group was 4.05, as opposed to 5.26 in the moderate group. Means of the low and moderate performing were 4.11 and 5.12, respectively. There were also major differences in baseline skills whereby the moderate-performing group had better results compared to that of low-performing group as was reported in previous CAD education studies.

Table 1: Pre-Test Results of Technical Drawing Skills

Skill	Low-Performing Group (n=45)	Moderate-Performing Group (n=45)
Orthographic Projection	M = 7.02, SD = 1.10	M = 9.12, SD = 1.05
Isometric Drawing	M = 6.73, SD = 1.15	M = 9.01, SD = 1.08
Spatial Visualization	M = 4.05, SD = 0.95	M = 5.26, SD = 0.90
Precision	M = 4.11, SD = 1.00	M = 5.26, SD = 0.90

M = Mean, SD = Standard Deviation.

Analysis of Technical Drawing Skills after the Training Programme

Technical drawing statistics in Table 2 are in post-test form after 90 students were tested at the end of the experiments. In the case of orthographic projection, the low scoring group (n=45) obtained an average score of 9.03 but the score of moderate performance group (n=45) was 10.01. In case of isometric drawing the means were 9.07 and 10.21 respectively. Mean score on spatial visualization was 5.56 (low-performing), and 6.11 (moderate-performing). The mean scores according to precision were 5.60 (low-performing) and 6.01 (moderate-performing).

Post-Test Results of Technical Drawing Skills

Skill	Low-Performing Group (n=45)	Moderate-Performing Group (n=45)
Orthographic Projection	M = 9.03, SD = 1.05	M = 10.01, SD = 1.00
Isometric Drawing	M = 9.07, SD = 1.10	M = 10.21, SD = 1.05
Spatial Visualization	M = 5.56, SD = 0.90	M = 6.11, SD = 0.85
Precision	M = 5.60, SD = 0.95	M = 6.01, SD = 0.90

M = Mean, SD = Standard Deviation

Table 3 shows the mean score differences between pre- and post-tests. Significant improvements of all groups were observed after orthographic projection, isometric drawing, spatial visualization, and precision with greater improvements in the low-performing group. This indicates that AutoCAD training was better with the low-performing students, and this may be the case because they had more areas in need of improvement. There was increased accuracy of spatial visualization and precision than orthographic projection probably due to the focus of the 12-lesson training being on 3D modeling rather than 2D drafting. Surprisingly, not much literature is available about the CAD training in Nigeria, which makes it difficult to compare information.

Table 3: Pre-Test and Post-Test Mean Score Differences

Skill	Low-Performing Group (n=45)	Moderate-Performing Group (n=45)
Orthographic Projection	$\Delta M = 2.01$ (7.02 to 9.03)	$\Delta M = 0.89$ (9.12 to 10.01)
Isometric Drawing	$\Delta M = 2.34$ (6.73 to 9.07)	$\Delta M = 1.20$ (9.01 to 10.21)
Spatial Visualization	$\Delta M = 1.51$ (4.05 to 5.56)	$\Delta M = 0.85$ (5.26 to 6.11)
Precision	$\Delta M = 1.49$ (4.11 to 5.60)	$\Delta M = 0.89$ (5.12 to 6.01)

ΔM = Mean score difference (pre-test to post-test).

Motivation Assessment

The motivation survey results, collected from 90 students yielded an average score of 130.2 on a scale of 96 to 165, indicating moderate to high engagement with AutoCAD training. The highest mean scores were on the attention subscale ($M = 43.76$) and confidence subscale ($M = 43.63$), suggesting that the AutoCAD learning scenario captured students' interest and boosted their confidence in technical drawing tasks. The lowest mean score was for the significance factor ($M = 43.48$), indicating less perceived relevance to future careers. The highest mean score was for item 8, implying that AutoCAD's interactive features strongly

engaged students. These findings align with studies on CAD-based education, highlighting digital tools' role in enhancing motivation.

Table 4: Motivation Survey Results

Subscale	Mean Score (M	Standard Deviation (SD)
Attention	43.76	2.10
Confidence	43.63	2.05
Significance	43.48	2.15
Overall	130.2	6.30

Scores are on a scale of 96–165 (overall) and 32–55 (subscales). Item 8 (attention) had the highest individual score.

Thus, it was revealed that 77 students rated it “mostly true” that AutoCAD’s interactive features were appealing. Over half (55) found it “mostly true” that AutoCAD’s interface helped maintain attention during lessons (item 17). Additionally, 40 students noted it was “mostly true” that the AutoCAD training’s introduction was engaging (item 2). Only 8 students found the content difficult (item 3), while 83 rated it “mostly true” or “very true” that well-structured AutoCAD resources boosted confidence in learning (item 35). The highest mean score was for item 36 ($M = 4.5$), with 77 students finding the AutoCAD lessons enjoyable. Significance was the lowest-rated factor, with no item scoring above 4.0; items 18 and 30 showed low scores, as only 16 students found explanations sufficient, and 27 related contents to personal experience. Statistical analysis indicated that AutoCAD training significantly improved technical drawing skills (orthographic projection, isometric drawing, spatial visualization, precision), particularly for low-performing students. Foundational drafting skills influenced outcomes, suggesting integration of manual and digital methods. AutoCAD’s intuitive interface enhances engagement, supporting skill development in vocational contexts.

Conclusions

The study demonstrated that the percentage increase in post-test technical drawing scores compared to pre-test scores was higher in the low-performing group. This suggests that the AutoCAD-based training significantly improved skills in orthographic projection, isometric drawing, spatial visualization, and precision for students with lower baseline abilities. The moderate-performing group showed smaller gains, indicating less pronounced improvement. The analysis could not definitively attribute these results to AutoCAD alone, warranting further investigation. The findings support the integration of digital tools like AutoCAD into technical drawing curricula, particularly for low-performing students in resource-constrained settings like Lagos State. AutoCAD training diversified learning, maintained student motivation, and enhanced skills without costly materials. Future research should explore other CAD tools, their impact on academic performance, cognitive load, and student engagement, to further optimize technical education in Nigeria.

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