Journal of Theoretical and Empirical Studies in Education
Vol. 10 Issue 3; August, 2025; ISSN: 2360-7172

Development and Evaluation of a Multimedia-Enhanced Virtual Learning Environment for Teaching Difficult Technical Drawing Concepts and Gender-Based Reactions in Nigerian Secondary Schools

Nathaniel Samuel, Ph.D
Department of Educational Technology, Faculty of Specialised and Professional Education, Emmanuel Alayande University of Education Oyo, Oyo State, Nigeria.

Adekemi Yewande Karimu Ph.D.
Leeds Trinity University, Faculty of Business, Computing and Digital Industries, School of Computer Science, United Kingdom
2317444@leedstrinity.ac.uk/karimuay@gmail.com

Olufumbi Jimoh Akorede Ph.D
[3]Department of Educational Technology, College of Professional and Specialised Education, Tai Solarin University of Education Ijagun, Ogun State,Nigeria
Email of the corresponding author:
nathanielsamuel@yahoo.com/samueln@eauedoyo.edu.ng

Abstract
This study explored the effectiveness of a developed multimedia-based Virtual Learning Environment (VLE) in facilitating students' comprehension of complex concepts in Technical Drawing, with particular attention to perceptions, gender-based reactions, and instructional design quality. Guided by the ADDIE model, the VLE addressed persistent challenges in teaching orthographic projection, sectional views, and assembly drawing in Nigerian secondary schools due to continued reliance on traditional and manual teaching methods. Quantitative analysis of students' perceptions (n = 54) revealed highly favorable responses, with itemised mean scores ranging from 3.3 to 3.8 and a grand mean of 3.5. Students found the VLE usable, pedagogically rich, and engaging, especially in its capacity to simplify difficult content and foster individualized learning. Regarding gender, male students reported slightly higher attitude scores (M = 3.38) than females (M = 3.23), though the difference was not statistically significant, $t(52) = 1.67$, $p > .05$. This suggests the VLE's inclusiveness across gender lines. Expert evaluation by educational technologists yielded a grand mean of 3.5, validating the platform's design as learner-centered, procedurally structured, and interaction-rich. Most notably, a paired samples t-test confirmed a significant improvement in academic performance post-intervention, $t(53) = 28.41$, $p < .001$, with a very large effect size (Cohen's $d = 3.85$). The findings collectively endorse the VLE as a highly effective, engaging, and inclusive instructional tool for Technical Drawing pedagogy in contemporary digital classrooms.

Keywords: Virtual Learning Environment, Technical Drawing, Multimedia Instruction, Instructional Design, Student Academic Performance,

Introduction

The acquisition of sound knowledge in technical and engineering drawing forms a critical foundation for the technological development of any nation. As a universal language, technical drawing enables engineers, architects, and craftsmen to communicate complex ideas and designs efficiently (Igbinomwanhia & Aliu, 2013). It plays a pivotal role in the conceptualization and fabrication of diverse machinery, ships, and structural frameworks. According to Oviawe (2016), technical drawing involves the pictorial representation of objects using symbols, lines, and diagrams, thereby allowing effective communication among technical professionals. Similarly, Abdulwahab and Usman (2014) assert that technical drawing supports practical and technological problem-solving through communication processing skills. Ogundola (2017) reiterated that mastering technical drawing equips learners with competencies such as reading engineering schematics, abstracting data from calculation sheets, producing accurate working diagrams, and understanding the spatial layout of machines and equipment for fabrication purposes. Despite its relevance, technical drawing is traditionally taught using manual tools like drawing boards, pencils, set-squares, protractors, compasses, and French curves - methods that are now perceived as time-consuming and laborious.

Globally, the trend has shifted toward integrating Information and Communication Technologies (ICTs) in education, and technical drawing is no exception. The adoption of ICT tools has been shown to simplify the teaching and learning process, facilitating faster and more accurate creation and interpretation of technical illustrations (Oviawe, 2016). ICT-based methods provide dynamic and interactive instructional environments that enhance student interest and equip them with globally relevant engineering drawing skills. The primary objectives of teaching technical drawing using ICT include improving learners' understanding of abstract concepts, facilitating the visualization of ideas, and supporting applications in manufacturing, design, and construction industries. As documented by the Nigerian Educational Research and Development Council (NERDC, 2007) and the Federal Republic of Nigeria (FRN, 2013), leveraging electronic tools for

technical education promotes entrepreneurship, enhances pedagogical quality, and aligns with global education trends.

The rise of Virtual Learning Environments (VLEs), such as Moodle, Edmodo, Schoology, and other collaborative platforms has revolutionized content delivery and engagement in education. VLEs allow asynchronous interaction, overcoming temporal and spatial barriers to learning (Cavus, 2011; Al-Busaidi & Al-Shihi, 2012). They also provide structured environments for managing learning content, assessing student progress, and promoting active participation (Sneha & Nagaraja, 2013). Kanaani and Elahi (2012) emphasize that VLEs address the limitations of traditional classroom practices by offering more motivating, accessible, learner-centered experiences; and brought about the widespread innovations in instructional delivery that enable students to grasp complex content more quickly and efficiently (Barker & Gossman, 2013). Despite the attributable advantages attached to engagement of VLEs for learning, their utilization in Nigerian schools remains low, largely due to infrastructural deficiencies, lack of training, and attitudinal barriers (Anierobi, Ezeonwumelu, Alaribe & Apiti, 2024; Awang, Aji, & Osman, 2016), especially to teaching and learning of Technical Drawing. Moreover, students often perceive some concepts such as orthographic projection, auxiliary views, sectioning techniques, and assembly drawings (Obi & Offorma, 2014; Nwachukwu & Okoye, 2018) as difficult in technical drawing.

Studies on empirical evidences conducted by Dahlstrom, Brooks and Bichsel (2014) on effectiveness of VLE revealed that 83% of students use VLEs for academic purposes and 85% of teachers access these platforms for instruction. Moreover, 74% of instructors acknowledge the role of VLEs in improving teaching quality, while 71% affirm their usefulness in enhancing student learning. Interestingly, 99% of sampled institutions in their study confirmed regular access and integration of VLEs into their instructional framework. Gambari, Yaki, Gana, and Ughovwa (2014) found that video-based multimedia instruction significantly improves students' achievement and retention in biology. Their findings suggest that multimedia tools - combining animations, voice-

overs, and texts, when paired with students' positive attitudes, contribute to better pedagogical outcomes.

Attitude plays a significant role in the adoption and effectiveness of technological tools in education. According to Zubković et al. (2016), attitude reflects individuals' beliefs, behaviours, and values toward a specific activity, often shaped by formal and informal learning experiences. In the context of technical drawing, students' attitudes can significantly influence how they engage with instructional tools, particularly when new technologies are introduced. Nevertheless, in developing countries like Nigeria, challenges such as limited access to ICT tools, inadequate training of teachers, and poor deployment of digital infrastructure hinder the full integration of VLEs into the classroom (Ajayi, 2020). These issues result in inconsistent instructional delivery and hinder the transformation of technical education through digital innovation.

In light of these challenges, this study developed a Virtual Learning Environment tailored to address the specific difficulties students face in learning technical drawing concepts such as orthographic projection, auxiliary projections, sectioning techniques, and working/assembly drawings. The development process adopted the ADDIE model - Analysis, Design, Development, Implementation, and Evaluation - a widely recognized instructional design framework (Deif, 2013). Furthermore, the study evaluated the effectiveness of the developed VLE in enhancing student learning outcomes and attitudes, particularly across gender lines. The virtual tool integrated multimedia features such as simulations, animations, and voice narration intended to enhance engagement and facilitate experiential learning (Agbatogun, 2010; Oyelekan & Olorundare, 2019).

Technical Drawing serves as a critical foundation for science, technology, engineering, and mathematics (STEM) education. It functions as a universal graphical language for communicating complex technical concepts, making its mastery essential for industrial development and national progress. Studying components of Technical drawing in secondary school curriculum is advantageous to students who intend to study science, technology, engineering, and mathematics (STEM) related course in tertiary institutions. However, factors such as lack of instructional resources, reliance on outdated

teaching methods, and students' low spatial reasoning skills negatively impact performance (Aina, 2013; Adegbija & Fakomogbon, 2013). These pedagogical bottlenecks call for innovative solutions that align with global educational standards and promote sustainable development in engineering and vocational education. Yusuf and Afolabi (2010) and Okonkwo (2017) maintain that ICT, when appropriately deployed, can facilitate competency-based education, reduce learning barriers, and improve overall instructional delivery. Nonetheless, empirical studies examining VLE applications in Nigerian secondary-level technical drawing remain sparse (Onasanya, Shehu, & Oduwaiye, 2011), thereby necessitating further research. This study, therefore, assessed the performance and perceptions of teachers, educational technologists, and students toward a developed VLE, with a focus on improving instructional quality in teaching perceived difficult concepts in technical drawing.

Statement of the Problem

The integration of Virtual Learning Environments (VLEs) has revolutionized instructional delivery globally by fostering flexible, technology-driven, and learner-centered pedagogy (Means, Toyama, Murphy, & Baki, 2013; Johnson, Adams Becker, Estrada, & Freeman, 2015). VLEs enhance teaching through interactive tools that support real-time feedback, visualization of abstract concepts, and self-paced learning (Almarashdeh, 2016; Sun, Tsai, Finger, Chen, & Yeh, 2008). However, in Nigeria, their use for teaching specialized subjects like Technical Drawing remains limited and underexplored (Awang, Aji, & Osman, 2016). Technical Drawing in Nigerian secondary schools is still taught using traditional manual tools such as drawing boards and set squares, which are time-consuming and cognitively disengaging (Aduwa-Ogiegbaen & Iyamu, 2005). These outdated methods are especially ineffective for complex topics like orthographic projection and sectional views, which demand high spatial reasoning (Akintola & Lawal, 2019). As a result, students consistently perform poorly in the subject, with declining enrolment (Ogundola, 2017). Research by Hassan and Maizam (2017) and Obi and Offorma (2014) attributes this trend to ineffective teaching strategies and inadequate instructional resources, leading to low motivation and poor understanding.

Nwachukwu and Okoye (2018) further note that difficult concepts often cause cognitive overload and reduced academic achievement.

Globally, ICT tools, particularly VLEs, have been shown to improve engagement and mastery in technical subjects (Ifinedo, 2017; Ally, 2008). Yet, Nigeria faces infrastructural deficits, limited ICT access, low digital literacy, and a shortage of trained educators (Awang et al., 2016; Okebukola, 2007), hindering the adoption of VLEs. These systemic barriers compound existing educational inequalities and challenge the effective integration of educational technologies (Unwin, 2009; Jegede, 2009). This revealed the existence of a research gap regarding the development and evaluation of VLEs that is tailored to the instructional needs of Technical Drawing in Nigerian schools (Yusuf & Afolabi, 2010). Moreover, the influence of gender on students' attitudes and performance in VLE-supported environments remains under-investigated (Tella, Tella, Toyobo, Adika & Adeyinka, 2007; Kayode & Ojo, 2011; Adebayo & Olatunbosun, 2014). This study therefore investigated these gaps by developing a multimedia-enhanced VLE using the ADDIE model as guide, targeting complex concepts in Technical Drawing. It also evaluates the VLE's effect on students' academic performance and attitudes, while also examining gender-related differences.

Research Objective

1. To examine students' perceptions on the effectiveness, usability, and engagement features of the developed Virtual Learning Environment in facilitating the learning of difficult Technical Drawing concepts.
2. To investigate gender-based differences in students' reactions to the use of the developed Virtual Learning Environment in learning Technical Drawing.
3. To determine the extent to which the design of the developed VLE support learner-centered instruction, procedural engagement, and interaction in Technical Drawing.
4. To determine the effect of the developed virtual learning environment on students' performance in selected technical drawing concepts for pedagogic experiences.

5. To examine gender differences in students' attitudes towards the developed virtual learning environment in learning selected technical drawing concepts.

Research Questions

1. What is the perceptions of students towards effectiveness, usability, and engagement features of the developed Virtual Learning Environment in facilitating the learning of difficult Technical Drawing concepts?
2. What is the reactions of male and female students towards the use of the developed VLE in learning Technical Drawing?
3. To what extent does the design of the developed VLE support learner-centered instruction, procedural engagement, and interaction in Technical Drawing?

Research Hypotheses

The following research hypotheses were tested in this study:

H_{O1}: There is no significant difference between the pretest and post-test of students' performance when exposed to the developed virtual learning environment on the selected technical drawing concepts for pedagogic experiences.

H_{O2}: There is no significant difference in the reaction (attitude) of male and female students towards the developed virtual learning environment on the selected technical drawing concepts for pedagogic experiences.

Methodology

This study adopted a quasi-experimental pretest-post-test design involving one group. The approach was aimed at determining the effect of a developed Virtual Learning Environment (VLE) on students' academic performance and attitudes towards selected concepts in Technical Drawing. The study also incorporated descriptive and inferential analyses to assess gender-based differences in student responses.

The population for this study comprised all senior secondary school students offering Technical Drawing in Ogbomoso (Oyo State) and Ilorin (Kwara State), Nigeria. It also included Technical Drawing teachers and Educational Technologists from Emmanuel Alayande University of Education, Tai Solarin University of Education, and

the University of Ilorin, who served as expert evaluators of the developed instructional platform. The sample consisted of 54 senior secondary school students (27 males and 27 females) who participated in testing the effectiveness of the Virtual Learning Environment (VLE). Additionally, 10 experts (5 Technical Drawing teachers and 5 Educational Technologists) were purposively selected to assess the VLE's content quality, technical features, instructional design, and presentation. While purposive sampling was used to select the experts based on their professional relevance, intact class sampling was employed for student selection, as random assignment was impractical within the existing school structure.

Three instruments were used for data collection. The Technical Drawing Performance Test (TDPT) measured students' academic performance before and after exposure to the Virtual Learning Environment (VLE), capturing learning gains. The Students' Attitude Questionnaire (SAQ)**,** a 10-item Likert-scale instrument, assessed students' perceptions and reactions to the VLE. The Teachers' and Educational Technologists' Assessment Questionnaire evaluated the VLE's content quality, technical features, design, and instructional organization using a structured 4-point Likert scale from Strongly Agree to Strongly Disagree.

The instruments were validated by experts in Educational Technology and Measurement and Evaluation from Emmanuel Alayande University of Education, Tai Solarin University of Education, and the University of Ilorin. Their reviews ensured clarity, relevance, and construct alignment. Reliability was established using Cronbach's Alpha: the Technical Drawing Performance Test (TDPT) recorded a coefficient of 0.82, the Students' Attitude Questionnaire (SAQ) 0.87, and the Teachers' and Educational Technologists' Assessment Questionnaire 0.91. These values confirm strong internal consistency and suitability of the instruments for the study.

Data collection followed four structured phases to ensure accuracy and internal validity. Firstly, students took the Technical Drawing Performance Test (TDPT) as a pretest to establish baseline performance. Secondly, during the implementation phase, students engaged with the developed Virtual Learning Environment (VLE) under guided

supervision. Third, a post-test using the same TDPT measured academic improvement. Finally, in the evaluation phase, students completed the Students' Attitude Questionnaire (SAQ), while experts comprising technical drawing teachers and educational technologists assessed the VLE using a structured evaluation tool. All activities were closely supervised to maintain consistency and validity.

Data were analyzed using SPSS Version 21.0, employing both descriptive and inferential statistics. Mean and standard deviation were used to evaluate students' attitudes toward the VLE and summarize expert assessments of its content, technical quality, design, and organization. A paired samples t-test was used to test Hypothesis 1, comparing students' academic performance before and after VLE exposure. An independent samples t-test assessed Hypothesis 2, examining gender differences in students' attitudes. Cohen's d was also calculated to determine the practical significance of observed effects.

Table 1: Demographic Distribution of the Study's Samples

Demographics information	Frequency
Experts	
Technical Drawing Teachers	5
Educational Technologists	5
Total	**10**
Students' Gender	
Male	27
Female	27
Total	**54**

Table 1 revealed the demographic information of the study's samples of experts and students' gender. The technical drawing and educational technologist

Research Question 1: How do students perceive the effectiveness, usability, and engagement value of the developed VLE in enhancing their learning of difficult concepts in Technical Drawing?

Table 2: Students' Reaction towards the Developed Virtual learning environment

S/No	Items	Means
1	The contents of the developed virtual learning environment improved my performance in Technical Drawing	3.4
2	The developed virtual learning environment is easy and simple to manipulate for improved learning.	3.5
3	I found the developed virtual learning environment easy to comprehend difficult concepts in Technical Drawing.	3.3

4	The contents in the developed instructional platform contained relevant pedagogic information to comprehend each concept.	3.6
5	Fiddling through the platform of developed virtual learning environment makes learning interesting and understandable.	3.5
6	The usage of the developed instructional platform improves my understanding on the perceived difficult concepts on Technical Drawing.	3.7
7	The use of developed virtual learning environment on the selected Technical Drawing concepts for pedagogical experiences facilitates individualistic learning.	3.6
8	I found the use of developed virtual learning environment very interesting and stimulating in learning perceived difficult concepts in Technical Drawing.	3.8
9	The use of developed virtual learning environment arouses my interest towards learning.	3.6
10	The use of developed virtual learning environment exposes the learner to procedural steps on learning of perceived difficult concepts in Technical Drawing.	3.4
	Grand mean Score	**3.5**

Table 2 presents students' reactions to the use of the Virtual Learning Environment (VLE) for pedagogical experiences. Mean scores ranged from 3.3 to 3.8, indicating that students found the VLE easy to use (3.5), effective in simplifying difficult concepts (3.3), and rich in relevant pedagogical content (3.6). They reported that the platform enhanced interest (3.6), supported individual learning (3.6), and improved understanding of challenging concepts (3.7). The highest rating (3.8) reflected how stimulating and engaging the platform was. With a grand mean of 3.4, well above the 2.5 benchmark, the findings reflect a generally positive student response toward the VLE's effectiveness in facilitating learning.

Research Question 2: Is there a significant difference in the reactions of male and female students towards the use of the developed VLE in learning Technical Drawing?

Table 3: Students' Reaction towards the Developed Virtual learning environment Based on Gender

S/No	Items	Means Scores	
		Male	Female
1	The contents of the developed virtual learning environment improved my performance in Technical Drawing	3.7	3.4
2	The developed virtual learning environment is easy and simple to manipulate for improved learning.	3.2	2.9
3	I found the developed virtual learning environment easy to comprehend difficult concepts in Technical Drawing.	3.6	3.4
4	The contents in the developed instructional platform contained relevant pedagogic information to comprehend each concept.	3.1	3.5

5	Fiddling through the platform of developed virtual learning environment makes learning interesting and understandable.	3.2	3.0
6	The usage of the developed instructional platform improves my understanding on the perceived difficult concepts on Technical Drawing.	3.3	3.1
7	The use of developed virtual learning environment on the selected Technical Drawing concepts for pedagogical experiences facilitates individualistic learning.	3.4	3.0
8	I found the use of developed virtual learning environment very interesting and stimulating in learning perceived difficult concepts in Technical Drawing.	3.6	3.4
9	The use of developed virtual learning environment arouses my interest towards learning.	3.5	3.2
10	The use of developed virtual learning environment exposes the learner to procedural steps on learning of perceived difficult concepts in Technical Drawing.	3.2	3.4
	Grand mean Score	**3.4**	**3.2**

Table 3 presents male and female students' reactions to the Virtual Learning Environment (VLE) for pedagogical experiences. Both groups reported positive perceptions, with grand mean scores of 3.4 (male) and 3.2 (female), exceeding the 2.5 benchmark. Male students consistently rated the VLE slightly higher across most items. They perceived the VLE as more effective in enhancing performance (3.7 vs. 3.4), simplifying difficult concepts (3.6 vs. 3.4), and facilitating interest and independent learning. Female students rated the content quality slightly higher (3.5 vs. 3.1) and found the procedural steps clearer (3.4 vs. 3.2). Overall, while both genders responded positively, male students showed a marginally stronger preference for the VLE. Subsequent tables (4 to 7) detail expert evaluations by Technical Drawing teachers and Educational Technologists on key aspects of the VLE, including content, technical quality, design, and presentation, particularly across selected concepts such as orthographic projection, auxiliary projections, sectioning techniques, and assembly drawing.

Research Question 3: To what extent does the design of the developed VLE support learner-centered instruction, procedural engagement, and interaction in Technical Drawing?

Table 4: Educational Technologists' Assessment on the Design, Development and Production of Virtual learning environment

S/No	**Items on the Design**	Mean score
1	The developed instructional platform incorporates procedural organization of graphical illustrations.	3.6
2	The developed VLE facilitate students' individualization of learning.	3.7
3	The logical presentation of concepts arouses students' interests towards learning of Technical Drawing.	3.5
4	The developed instructional platform facilitates interactions on pedagogical experiences.	3.6
5	The developed VLE facilitates learning by doing	3.2
6	The developed instructional platform allows learners to work independently.	3.6
7	The package allows learners to discover information through active exploration.	3.6
8	The developed VLE promotes collaborative learning.	3.4
9	The developed virtual learning environment allows learners to work individually.	3.3
10	The content in the developed instructional platform have relevant information to teach the selected concepts.	3.6
11	The contents in the developed instructional platform are easy to navigate.	3.5
12	The interface of the instructional platform is user-friendly	3.4
	Grand mean score	3.5

Table 4 shows the educational technologists' assessments on the design, development and production of virtual learning environment. The mean score of 3.6 on the developed instructional platform incorporates procedural organization of graphical illustrations, facilitate students' individualization of learning (3.7), logical presentation of concepts arouses students' interests towards learning of Technical Drawing (3.5), facilitates interactions on pedagogical experiences (3.6), facilitates learning by doing (3.2), allows learners to work independently (3.6), the package allows learners to discover information through active exploration (3.6), promotes collaborative learning (3.4), allows learners to work individually (3.3), have relevant information to teach the selected concepts (3.6), the contents in the developed instructional platform are easy to navigate (3.5) and the interface of the instructional platform is user-friendly (3.4). The grand mean score of 3.5 out of 5.0 exemplified that educational technologists' assessments on the design, development and production of virtual learning environment conformed to procedural steps involved in the production of virtual learning platform. The educational

technology experts adjudged that the design of the VLE for learning of technical drawing concepts incorporates the procedural organizations of graphical illustrations, facilitate individualization of learning experiences, user-friendly, promotes collaborative learning, and arouses students' interest thereby facilitating students' pedagogical experiences.

H_o1: There is no significant difference between the pretest and post-test of students' performance when exposed to the developed virtual learning environment on the selected technical drawing concepts for pedagogic experiences.

Table 5: Comparison of Students' Performance Scores before and after Exposure to the Virtual Learning Environment

Test	X	SD	t	df	p	Cohen's d	Interpretation
Pretest	45.00	7.50					
Post-test	70.00	8.20	28.41*	53	< .001	3.85	Significant improvement post-VLE exposure

*Note. Paired samples t-test; *p < .05

A paired samples t-test was carried out to determine whether there was a significant difference in students' academic performance before and after exposure to the developed Virtual Learning Environment (VLE). The analysis revealed a statistically significant improvement in mean scores, from the pre-test (M = 45.00, SD = 7.50) to the post-test (M = 70.00, SD = 8.20), with $t(53) = 28.41$, $p < .001$. The calculated Cohen's d of 3.85 indicates a very large effect size, demonstrating that the improvement was not only statistically significant but also educationally meaningful. Given these results, the null hypothesis (H_{o1}) which posited no significant difference between students' pre-test and post-test scores was rejected. This confirms that the multimedia-based VLE had a strong positive effect on students' learning outcomes in Technical Drawing. The evidence supports the conclusion that VLEs can significantly enhance students' comprehension and mastery of abstract and visually demanding technical concepts, particularly in subjects traditionally regarded as difficult.

H_o2: There is no significant difference in the reaction (attitude) of male and female students towards the developed virtual learning environment on the selected technical drawing concepts for pedagogic experiences.

Table 6: Comparison of Male and Female Students' Attitude Scores towards the Virtual Learning Environment

Gender	X	SD	t	df	p	Cohen's d	Interpretation
Male	3.38	0.34					
Female	3.23	0.32	1.67	52	> .05	0.45	No significant difference in attitude scores

Note. Independent samples t-test; p > .05

To evaluate the impact of the developed Virtual Learning Environment (VLE) on students' academic performance in Technical Drawing, a paired samples t-test was conducted. Results revealed a significant improvement, with mean scores rising from 45.00 (SD = 7.50) in the pre-test to 70.00 (SD = 8.20) in the post-test. The t-value of 28.41 (df = 53) and $p < .001$ indicated a highly significant difference. The large effect size (Cohen's d = 3.85) confirmed that the improvement was not only statistically meaningful but also educationally substantial. Consequently, the null hypothesis was rejected, affirming that the multimedia-enhanced VLE significantly improved students' understanding of technical drawing concepts, especially those typically challenging to master through traditional instruction. In contrast, an independent samples t-test assessed gender differences in students' attitudes toward the VLE. Male students had a slightly higher mean attitude score (M = 3.38, SD = 0.34) compared to females (M = 3.23, SD = 0.32). However, with a t-value of 1.67 (df = 52) and $p > .05$, the difference was not statistically significant. Although Cohen's d = 0.45 suggested a small-to-moderate effect size, the null hypothesis was retained. This implies that both male and female students responded similarly to the VLE, highlighting its gender-inclusive effectiveness in promoting engagement and enhancing learning in technical drawing.

Discussion of Findings

The findings of this study confirm that a well-designed Multimedia Virtual Learning Environment (VLE) significantly enhances the teaching and learning of Technical Drawing, a subject often described as cognitively demanding and difficult for students to master especially in complex areas like orthographic projections and sectional views (Ogundola, 2017; Obi & Offorma, 2014). Consistent with studies by Oviawe (2016) and Gambari et al. (2014), the study affirms that VLEs promote better conceptual clarity, engagement, and content simplification through multimedia features like

animations and simulations. Students in this study reported that the VLE simplified difficult concepts, supported visual learning, and provided an interactive experience that aligns with constructivist principles, echoing Yusuf and Afolabi's (2010) advocacy for ICT in enhancing competency-based education.

Moreover, the positive attitude exhibited by the students toward the VLE particularly their increased motivation and interest supports Zubković *et al.*'s (2016) claim that learner attitudes and shaped by digital engagement are crucial for adoption and sustained use of educational technology. The learner-centered design of the VLE, with its flexibility and adaptability to individual cognitive levels, enabled self-paced learning and resonated with prior findings that suggest digital tools promote autonomy in learning (Adebowale & Dare, 2020). Expert validation from subject teachers and educational technologists in this study further confirmed its pedagogical soundness and usability, supporting Deif's (2013) position on the robustness of the ADDIE model in instructional design.

The statistically significant improvement in students' post-test performance further reinforces prior global evidence (Dahlstrom et al., 2014) that VLEs improve academic achievement and instructional quality. However, in contrast to some earlier findings that hinted at gender disparities in technology use and engagement in STEM subjects (Ajayi, 2020; Tella & Mutula, 2008), this study found no significant gender-based differences in students' reactions to or performance with the VLE, indicating a shift toward greater digital inclusivity. This divergence may be attributed to the context-specific, user-centered design of the VLE, which promoted equal usability for both genders.

Nevertheless, the study challenges assertions in some literature that emphasize infrastructural and technical barriers as limiting factors to the effectiveness of VLEs in Nigerian schools (Ololube *et al.*, 2015). In contrast, this study's successful implementation suggests that with careful design and expert input, even resource-limited contexts can benefit from digital innovation in education. While the literature cautions about inconsistent policy support and teacher preparedness (Aduwa-Ogiegbaen & Iyamu, 2005), the present findings advocate that such barriers can be mitigated with targeted

capacity building and proper instructional planning. The statistically significant improvement in students' performance following VLE exposure confirms its instructional value. This study contributes empirical evidence to the growing support for integrating VLEs in technical education. It confirms several positive outcomes from past research, such as enhanced engagement and learning outcomes, while offering a nuanced perspective that challenges long-held concerns around gender disparity and infrastructural limitations. The results point to a strong need for scaling up digital initiatives, contextual design, and sustainable educational policies that foster inclusive and effective learning environments in Nigeria.

These results are in line with global studies (Dahlstrom *et al*., 2014) demonstrating the positive impact of VLEs on teaching quality and academic outcomes. By reducing cognitive load and supporting active learning, the VLE contributed meaningfully to students' mastery of previously difficult concepts. In conclusion, this study underscores the pedagogical relevance and gender-inclusiveness of VLEs in technical education. It calls for increased investment in digital infrastructure, teacher capacity building, and policy reforms to promote widespread adoption. The evidence strongly supports the integration of contextually designed VLEs as a sustainable solution for improving instructional delivery and learner performance in Technical Drawing.

Conclusion

This study demonstrated that a well-designed Virtual Learning Environment (VLE), developed using the ADDIE instructional model and enhanced with multimedia features, significantly improved students' understanding and engagement with difficult concepts in Technical Drawing. Students perceived the VLE as effective, user-friendly, and engaging, which corresponded with statistically significant gains in academic performance. Subject experts validated the platform for its pedagogical soundness, instructional design, and technical quality, emphasizing its capacity to facilitate individualized and collaborative learning. Importantly, no significant gender-based

differences were found in students' attitudes toward the VLE, underscoring its inclusivity and adaptability across learner demographics.

The findings confirm the usefulness of VLEs as a transformative instructional strategy, especially in Nigerian secondary schools where traditional teaching is often hindered by infrastructural and pedagogical limitations. The VLE's interactive and structured content delivery helped simplify complex technical concepts, making them more accessible and memorable for learners. These results resonate with earlier studies that highlighted the benefits of digital learning environments in improving student engagement and academic outcomes, while differing from research that identified inconsistent impacts of VLEs due to issues of poor design or lack of contextual fit. Ultimately, this study provides compelling evidence that VLEs, when thoughtfully designed and contextually relevant, offer a scalable and inclusive approach to enhance teaching and learning in technical subjects. The developed VLE stands as a promising instructional innovation that can bridge educational gaps, promote digital transformation, and support the broader pursuit of quality and equity in Nigeria's education system.

Recommendations

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

1. Educational policymakers and school administrators should formally adopt Virtual Learning Environments as complementary instructional tools, particularly in technical subjects like Technical Drawing.
2. The positive student perception and expert validation of the VLE developed in this study demonstrate the importance of teacher involvement in instructional design to enhance contextual relevance. Therefore, teachers should be trained via organization of seminar, workshops and in-service training not only to use existing VLEs but also to design and adapt them to suit specific content areas.
3. Educational stakeholders should encourage the promotion of equitable access to digital learning tools, by ensuring that all students irrespective of gender should benefit from innovative instructional strategies.

4. Government and non-governmental organisations should invest in ICT infrastructure (including internet access, electricity, and devices) to maximize the effectiveness and to support Virtual Learning Environment.
5. Nigerian teacher education institutions should encouraged more inclusions of the principles of instructional design and multimedia-based learning environments into the curriculum. This will prepare and facilitate future teachers to develop and implement VLEs effectively in their classrooms.
6. Nigerian school systems should establish mechanisms for ongoing evaluation of instructional technologies like VLEs to ensure meeting the established learning objectives, remain engaging, and are technically sound. The receipt of valued feedbacks from both students and subject experts should inform iterative improvements.

References

Abdulwahab, S. & Usman, A. (2014). Competencies Required by Technical drawing Teachers in Technical Colleges, *Journal of Research & Method in Education, 4(2), 32-37.*

Adebayo, F. O., & Olatunbosun, H. A. (2014). Effect of multimedia instruction on students' cognitive achievement in social studies. *Journal of Education and Practice*, 5(19), 14–20.

Adegbija, M. V., & Fakomogbon, M. A. (2013). *Instructional materials and resource utilization in teaching technical education in Nigeria*. *International Journal of Technical Education*, *18*(2), 102–115.

Aduwa-Ogiegbaen, S. E., & Iyamu, E. O. S. (2005). Using information and communication technology in secondary schools in Nigeria: Problems and prospects. *Educational Technology & Society*, 8(1), 104–112.

Agbatogun, A. O. (2010). Effect of Multimedia-Based Instruction on Senior Secondary Students' Achievement and Retention in Biology in Nigerian Schools. *Eurasia Journal of Mathematics, Science & Technology Education*, *6*(4), 263–273.

Aina, J. K. (2013). Effects of instructional resource inadequacy on students' performance in Technical Drawing: A study of Nigerian secondary schools. *Journal of Technical and Vocational Education*, *15*(1), 45–56.

Ajayi, V. O. (2020). Barriers to the integration of ICT in Nigerian secondary school technical education: A study of teacher perceptions. *International Journal of Educational Development*, *75*, 102234.

Akintola, O. I., & Lawal, F. A. (2019). Analysis of students' performance in technical drawing in senior secondary schools. *Nigerian Journal of Technical Education*, 12(2), 43–50.

Al-Busaidi, K. A. & Al-Shihi, H. (2012). Key Factors to Instructors' Satisfaction of Learning Management Systems in Blended Learning. *Journal of Computing in Higher Education*, *24*(1), 18–39.

Ally, M. (2008). Foundations of educational theory for online learning. In T. Anderson (Ed.), *The theory and practice of online learning* (pp. 15–44). Athabasca University Press.

Almarashdeh, I. (2016). Sharing instructors experience of learning management system: A technology perspective of user satisfaction in distance learning course. *Computers in Human Behavior*, 63, 249–255.

Anierobi, E.I., Ezeonwumelu, V.U., Alaribe, C.O., Apiti, A. A.and Amobi, U.C. (2024). "Assessing Continuing Education Programme Students' Perception, Attitude, Readiness and Willingness to Adopt e-Learning in a Public University in Anambra State". Social Science and Humanities Journal, 8 (3), 34697 - 34706.

Awang, M. M., Aji, J. Z. K., & Osman, W. R. S. (2016). Students' attitudes and performance in learning Technical Drawing using blended learning. *Asian Social Science*, 12(7), 75–81.

Barker, K., & Gossman, P. (2013). *Enhancing student engagement through virtual learning environments in STEM education. Journal of Educational Technology*, *8*(2), 45–54.

Cavus, N. (2011). *Investigating mobile devices and LMS integration in higher education: Student perspectives. Procedia Computer Science*, *3*, 1469–1474.

Dahlstrom, E., Brooks, C., & Bichsel, J. (2014). The Current Ecosystem of Learning Management Systems in Higher Education: Student, Faculty, and IT Perspectives. Research report. Louisville, CO: ECAR, September. Available online: http://www.educause.edu/ecar.

Deif, M. (2013). Using instructional design principles to develop effective information literacy instruction: The ADDIE model. *College & Research Libraries News*, 74(4), 205–207.

Federal Republic of Nigeria (2013) National Policy on Education. 6th Edition, NERDC Press, Abuja.

Gambari, A. I., Yaki, A. A., Gana, E. S. and Ughovwa, Q. E. (2014). Improving Secondary School Students' Achievement and Retention in Biology Through Video-based Multimedia Instruction, *InSight: A Journal of Scholarly Teaching, 9, 78-91.*

Hassan, A., & Maizam, M. (2017). Evaluation of teaching methods used in Technical Drawing in Nigerian schools. *International Journal of Education and Development Using ICT*, 13(3), 112–125.

Hassan, B. & Maizam, A. (2017). The imperatives of Technical drawing skills in teaching TVET subjects: The case of Nigeria, *Journal of Education and Practice*, 8(23), 133-135.

Ifinedo, P. (2017). Examining students' satisfaction with learning management systems: An empirical study of the role of affective, behavioral, and cognitive engagement. *International Journal of Information and Learning Technology*, 34(2), 93–104.

Igbinomwanhia, D. I. & Aliu, S. A. (2013). Investigation of the continuing poor performance in engineering drawing in Nigerian universities – a case study of the University of Benin, *Research Journal in Engineering and Applied Sciences* 2(5) 346-350.

Jegede, O. J. (2009). The impact of ICT on professional development and educational delivery in Nigeria. *ICT for Development: Contributing to the Millennium Development Goals*, 6, 8–18.

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015). *NMC Horizon Report: 2015 K–12 Edition*. The New Media Consortium.

Kanaani, F., & Elahi, S. (2012). A model for measuring e-learning system success in universities. *Expert Systems with Applications*,39(12), 10959–10966

Kayode, D. J., & Ojo, B. Y. (2011). Effective use of ICT for teaching and learning in Nigerian tertiary institutions. *International Journal of Research in Education*, 3(2), 68–75.

Means, B., Toyama, Y., Murphy, R., & Baki, M. (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teachers College Record*, 115(3), 1–47.

Nigerian Educational Research and Development Council (NERDC) (2007). *Federal Ministry of Education senior secondary school curriculum for technical drawing for SSS 1-3*. Abuja: NERDC Press.

Nwachukwu, C. E. & Okoye, R. (2018). Students' perceptions of difficulty in technical drawing concepts: A study in Nigerian secondary schools. *Nigerian Journal of Technical Education Research, 12*(2), 58–66.

Nwachukwu, C. E., & Okoye, K. R. E. (2018). Strategies for improving students' academic performance in Technical Drawing in Nigerian secondary schools. *International Journal of Innovative Research and Development*, 7(2), 110–117.

Obi, M. N., & Offorma, G. C. (2014). Teachers' competence in the use of ICT in teaching Technical Drawing in Nigerian secondary schools. *Nigerian Journal of Curriculum Studies*, 21(3), 93–101.

Obi, T. N. & Offorma, G. C. (2014). Challenges in learning Technical Drawing in Nigerian secondary schools: Implications for instructional innovation. *Journal of Vocational and Technical Education*, *10*(1), 23–32.

Ogundola, I. P. (2017). Technical Drawing as a predictor of engineering drawing achievement among technical college students. *International Journal of Educational Foundations and Management*, 11(1), 37–46.

Okebukola, P. (2007). Innovation and best practices in teacher education in Nigeria. *A Lead Paper Presented at the National Commission for Colleges of Education (NCCE) Annual Conference*.

Okonkwo, I. (2017). The influence of ICT on technical education: An assessment of Computer Assisted Instruction in Technical Drawing. *Journal of Technology Education and Management*, *22*(3), 198–210.

Onasanya, S.A., Shehu R.A, Oduwaiye R.O. & Shehu L. A. (2011). Higher Institutions Lecturers' Attitude towards Integration of ICT in Teaching and Research in Nigeria. *Research Journal of Information Technology*, 2, 1-10.

Oviawe, J. I. (2016). Benefits and Limitations of E-learning for Technical drawing in Edo State Model Secondary Schools, Nigeria. *International Journal of Academic Research in Progressive Education and Development 5(3), 52-64.*

Oyelekan, O. S., & Olorundare, A. S. (2019). Enhancing spatial reasoning through animation-supported learning in technical subjects. *Journal of Educational Multimedia and Hypermedia*, *28*(2), 173–194.

Sneha, J. M., & Nagaraja, G. S. (2013). Teaching and learning through *Virtual learning environments: A survey. International Journal of Computer Trends and Technology*, *4*(6), 1705–1709.

Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, 50(4), 1183–1202.

Tella, A., Tella, A., Toyobo, O. M., Adika, L. O., & Adeyinka, A. A. (2007). An assessment of secondary school teachers' uses of ICTs: Implications for further development of ICT use in Nigerian secondary schools. *The Turkish Online Journal of Educational Technology*, 6(3), 5–17.

Unwin, T. (2009). *ICT4D: Information and communication technology for development*. Cambridge University Press.

Yusuf, M. O., & Afolabi, A. O. (2010). Effects of computer assisted instruction (CAI) on secondary school students' performance in Biology. *The Turkish Online Journal of Educational Technology*, 9(1), 62–69.

Zubković, B. R., Kolić-Vehovec, S., Maglica, S., Smojver-Ažić, S., & Pahljina-Reinić, R. (2016). Attitudes toward virtual learning environments and their relation to academic performance in STEM subjects. *Computers & Education*, *98*, 39–52.