ACTION MODEL AS A MEASURE OF VALIDATING COMPUTER AIDED DRAWING LEARNING TOOL (CADLT) FOR TEACHING TECHNICAL DRAWING

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Abstract
This study explores the effectiveness of a Computer Aided Drawing Learning Tool (CADLT) in teaching technical drawing to secondary school students. The research involves experts (technical drawing teachers, educational technologists, and computer programmers/software developers) from five government technical colleges in Lagos State. Using the ACTION model, CADLT was evaluated by experts for accessibility, interactivity, and ability to enhance individualized learning. The findings show that CADLT is accessible, allowing students to use it without internet access, while also supporting self-paced learning. Experts noted that the tool is interactive and user-friendly, making it suitable for engaging students in complex technical concepts. Moreover, CADLT's innovative approach provides a digital alternative to traditional methods, motivating learners and improving their understanding of Technical Drawing. The study recommends wider adoption of such technologies in schools to enhance technical education. These findings suggest that CADLT can serve as a practical solution to modernize the teaching of technical subjects, helping students build relevant skills for the future.

Keywords: ACTION model, Computer Aided Drawing, Instructional Technology, Technical Drawing
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Introduction

Over the last two decades, the impact of design, development, evaluation, and validation of the technology and technological tools has changed the mode and manner of doing things such as how we live, how we communicate, how we learn, and other aspects of life (Huang, et al 2019); making technology-mediated learning more interactive, faster, easier and fun-filled, especially for developing countries like Nigeria. The complexity of today's world presents novel challenges, rapid changes, technological transformation, and new demands on all sectors globally, one of which is the educational sector (Usoro, 2010). Education is all effort put together to bring about change and improvement, in the behaviour and abilities of individual learners to become a competent factor that can bring about the development of a nation (Nurdin, Ambiyar & Nurhasansyah 2023). Technical drawing is a course of study within the technical and engineering education fields. Saue, Baritule & Wordu 2023).

Technical Drawing is intended to prepare learners to be self-reliant in society, for higher education and the industry in the related field or profession (FRN, 2013). It is also aimed at impacting learners by providing skill-filled experiences that bring about the acquisition of appropriate skills and attitudes needed in the construction-related field. To achieve these objectives, most recent innovative teaching techniques must be engaged, active participation of learners; which involves individualized learning, bridging the gap of learning differences and collaborative learning activities become imperative. If this need will be met, an active functional instructional tool will be needed (Gambari & Yusuf 2014). To achieve these, Computer

Aided Drawing and design tools are expedient in the teaching and learning of Technical Drawing at the post-basic school levels as stated in the (NERDC, 2013).

CAD software is designed to accurately represent various dimensions of technical drawings and engineering applications. These tools are essential for illustrating engineering and architectural projects (Almeida & Baratto, 2022). However, most existing CAD programmes cater primarily to industry professionals and do not adequately address the needs of teaching and learning Technical Drawing within West Africa. Almeida and Baratto (2022) emphasized the necessity of developing instructional tools that are simple and basic, tailored to the learners' level while preserving the essential content and principles of the subjects being taught. To facilitate the development and selection of suitable, usable, and standardized instructional tools, a guiding model is crucial. The selection of technology must be informed by a structured approach, as no technology should be implemented without guidance. For this study, the ACTION model was employed. The ACTIONS model serves as a framework for selecting e-technologies and media and involves the evaluation and input of experts, including the Project 57 manager, subject matter experts, instructional design experts, information technology professionals, and media specialists (Falode, 2014). A significant challenge that led to the creation of the ACTIONS model was the adaptation of face-to-face course materials for online or other remote learning environments.

According to Bates (1995), the acronym ACTIONS stands for Access, Cost, Teaching and Learning, Interaction and User-Friendliness, Organizational Challenges, Novelty, and Speed. The ACTIONS model provides designers with the flexibility to choose their steps when selecting technological tools or teaching and learning methods, particularly in subjects like technical drawing. To select the most appropriate media for specific educational or training goals, a media selection analysis must evaluate general and specific criteria, including instruction, student, and financial elements relevant to each delivery technology or instructional medium. Benevides and Macalam Saab Lima (2017) noted that the ACTION model resembles the Kripke model, where each action has prerequisites that must be fulfilled for the action can be performed.

Zaied (2007) conducted an empirical study to identify seven characteristics deemed essential for media selection by teachers, IT professionals, and students. Four of these characteristics align closely with Bates' requirements while the other three—professional growth, student self-motivation, and student satisfaction—are more aligned with success conditions and are difficult to define before making a selection (Hashim and Hash, 2014). Bates asserts that different types of knowledge and information are presented through various media which include: audio presentation, textual presentation, video media presentations and multimedia and integrated media in computer presentations. However, the emergence of new media complicates the role of media selectors. This raises the question: how should educators and trainers choose media?

The selection of technologies and tools must meet several requirements, including:

- Compatibility with a wide range of learning contexts
- Equal attention to educational and operational issues
- Consideration for various decision-making levels until the necessary skills are attained
- Adaptability to different contexts and content, ensuring the best-fit technology
- User-friendliness, ease of understanding, and accessibility
- Incorporation of recent technologies to address the needs of modern learners, as suggested by Bates.

Bates (2019) emphasized the importance of selecting instructional technology and tools that best suit the subject matter, students, and learning environment. Despite the rapid advancements in media and technology over the past two decades, Bates' (2019) review of more recent publications indicates that his ACTIONS model (Bates, 1995) remains relevant and widely used. As an improvement to the ACTIONS model, Bates introduced the SECTIONS model, which was developed for remote learning and aims to address the use of media in both on-campus and online learning (Moses, 2006). Some characteristics from Bates' models are included in Patsula's (2002) CASCOIME model, which adds additional factors such as socio-political suitability, cultural friendliness, and openness/flexibility to consider global perspectives. For this study, the Bates' ACTIONS model was used to validate the selection and usability of the developed computer-aided drawing learning tool (CADLT).

Research Questions

The following research questions were raised and answered in the study:

1. To what extent do experts consider CADLT a package that can be readily accessible to technical drawing students and teachers in Nigeria?
2. To what extent does CADLT meet the criteria for individualized learning of users?
3. To what extent do experts consider CADLT software an interactive and user-friendly tool for learning Technical Drawing?

Methodology

This study employed a descriptive research design to evaluate the effectiveness of a Computer Aided Drawing Learning Tool (CADLT) in teaching technical drawing. The research was conducted across five Government Technical Colleges in Lagos State, Nigeria, involving experts including Technical Drawing teachers, educational technologists, and computer programmers/software developers. The research instruments used for the study include the newly developed CADLT software and questionnaires. The CADLT software was developed over 16 months through collaboration with various stakeholders including teachers, educational technologists, and programmers. Data collection spanned two months, and the analysis employed descriptive The study focused specifically on geometric construction topics, including the construction of various angles (90°, 45°, 22.5°, 60°, 30°, and 15°), and the software was validated by subject matter experts, educational technology experts, and computer experts before implementation.

Results

Research Question 1: To what extent do experts consider CADLT a package that can be readily accessible to technical drawing students and teachers in Nigeria?

Table 1: *Accessibility of CADLT software package*

S/N	Statements	Mean	Std. Deviation	Decision
1	This software is available for users at home	3.60	0.52	Agree
2	All tools in the software are functional for teaching	3.50	0.71	Agree
3	The software is readily accessible	2.70	0.48	Disagree
4	Students can access CADLT software with or without a network connection	3.10	0.57	Agree
	Average Mean	3.22		

The findings in Table 1 provide valuable insights into the accessibility of the CADLT software package for technical drawing students and teachers in Nigeria. The results indicate that experts generally perceive the software as functional and available, but not necessarily easy to access. A significant number of respondents agreed that CADLT is available for users at home (Mean = 3.60, SD = 0.52), suggesting that students and teachers can install or access the software beyond the school environment. Additionally, there was agreement that all tools within the software are functional for teaching purposes (Mean = 3.50, SD = 0.71), reinforcing its suitability for instructional use. However, when asked whether the software is readily accessible, the response was negative, with a mean score of 2.70 (SD = 0.48). This suggests that while the software exists and functions well, users may face challenges in obtaining or using it conveniently. These challenges could stem from factors such as installation difficulties, licensing restrictions, or technical requirements. Furthermore, experts agreed that students can access CADLT with or without a network connection (Mean = 3.10, SD = 0.57), indicating that internet availability is not a major barrier to its usage. Overall, with an average mean score of 3.22, the results suggest that while CADLT is generally seen as accessible, there are notable concerns regarding its ease of access. Addressing these challenges, possibly by improving distribution methods, simplifying installation, or enhancing user support could further enhance its adoption and effectiveness in technical drawing education in Nigeria.

Research Question 2: To what extent does CADLT meet the criteria for individualized learning of users?

Table 2: *Potential CADLT to enhance individualized learning for learners*

S/N	Statements	Mean	Std. Deviation	Decision
1	The concepts in this CADLT software are relevant to learners' abilities	3.60	0.52	Agree
2	The application of this CADLT software is possible on issues related to their level	3.10	0.74	Agree
3	The content of this CADLT software is structured in a clear and understandable manner	3.30	0.67	Agree
4	The content of this CADLT software caters adequately for the skill acquisition of the learners	3.40	0.70	Agree
5	This CADLT software considers the individual differences of the learners	3.00	0.67	Agree
6	This CADLT software allows learners to work at their own pace	3.50	0.53	Agree
7	This CADLT software can be used by learners alone, without the need for other instructional objects	3.00	0.50	Agree
	Average Mean	3.27		

The findings in Table 2 provide insights into the extent to which CADLT supports individualized learning among users. Overall, the results suggest that experts agree that the software meets the criteria for individualized learning, as reflected in the average mean score of 3.27. Experts strongly agreed that the concepts in CADLT are relevant to learners' abilities (Mean = 3.60, SD = 0.52), indicating that the software aligns well with students' skill levels. Similarly, they affirmed that CADLT allows learners to work at their own pace (Mean = 3.50, SD = 0.53), a key characteristic of individualized learning. There was also agreement that the content is structured clearly and understandably (Mean = 3.30, SD = 0.67) and that it adequately caters to skill acquisition (Mean = 3.40, SD = 0.70). This suggests that the software is not only easy to follow but also provides opportunities for hands-on learning. Furthermore, experts agreed that CADLT considers individual differences among learners (Mean = 3.00, SD = 0.67), meaning it likely provides some level of adaptability to different learning needs. Similarly, the statement that CADLT can be used without the need for other instructional objects received a mean score of 3.00 (SD = 0.50), indicating that while the software is relatively self-sufficient, there may still be instances where supplementary materials could enhance learning. The findings indicate that CADLT effectively supports individualized learning by aligning with learners' abilities, enabling self-paced learning, and presenting content in a clear, skill-oriented manner. However, while the software generally meets the criteria, improvements in adaptability and self-sufficiency could further enhance its effectiveness in personalized learning experiences.

Research Question 3: To what extent do experts consider CADLT software an interactive and user-friendly tool for learning Technical Drawing?

Table 3: *Interactivity and the user-friendliness of the developed CADLT*

S/N	Statements	Mean	Std. Deviation	Decision
1	The structure of the CADLT software allows learners to move around freely in different units	3.00	0.67	Agree
2	The structure of this CADLT will permit learners to advance, review and repeat the unit.	3.10	0.57	Agree
3	This CADLT provides opportunities for interaction for the learners	3.40	0.52	Agree
4	This CADLT gives room for individualized learning	3.40	0.52	Agree
5	This CADLT gives room for learner-to-learner interaction while working	3.40	0.70	Agree
6	This CADLT will enable learners to have content interaction while constructing angles.	3.10	0.32	Agree
7	This CADLT will enable learner-to-tutor interaction while drawing	3.10	0.32	Agree
	Average Mean	3.21		

The findings presented in Table 3 highlight the extent to which experts consider CADLT software an interactive and user-friendly tool for learning Technical Drawing. With an average mean score of 3.21, the results suggest that experts generally agree that the software is designed to facilitate learner interaction, individualized learning, and engagement with content. Experts agreed that the software structure allows learners to navigate freely between different units (Mean = 3.00, SD = 0.67), as well as advance, review, and repeat units as needed (Mean = 3.10, SD = 0.57). This suggests that CADLT provides a flexible and self-paced learning experience, enabling students to revisit content as necessary. Interactivity is a crucial component of effective digital learning tools, and the results show that CADLT performs well in this regard. Experts agreed that the software provides opportunities for learner interaction (Mean = 3.40, SD = 0.52) and supports learner-to-learner interaction while working (Mean = 3.40, SD = 0.70). Additionally, CADLT facilitates learner-content interaction while constructing angles (Mean = 3.10, SD = 0.32) and learner-tutor interaction while drawing (Mean = 3.10, SD = 0.32), indicating that it allows students to engage meaningfully with both the material and instructors. Furthermore, the software was perceived to support individualized learning (Mean = 3.40, SD = 0.52), reinforcing its ability to cater to different learning speeds and styles. This aligns with the principles of student-centred learning, where learners can work at their own pace and interact with the content in ways that suit their individual needs.

The findings indicate that CADLT is an interactive and user-friendly tool that effectively supports Technical Drawing education. By allowing flexible navigation, self-paced learning, and multiple forms of interaction (learner-learner, learner-content, and learner-tutor), the software aligns well with modern instructional approaches. These results suggest that CADLT can significantly enhance student engagement, facilitate skill acquisition, and improve learning outcomes in Technical Drawing. However, further

enhancements in interactivity—such as more dynamic collaboration features or real-time tutor support—could further strengthen its effectiveness.

Discussion

The study revealed that the Computer-Aided Drawing Learning Tool (CADLT) is both accessible and suitable for Technical Drawing students and teachers. Experts agreed that it can be used effectively without an internet connection, aligning with Almeida and Baratto's (2022) findings on the importance of tools that cater to learners' needs regardless of connectivity. Additionally, CADLT was found to enhance individualized learning by allowing students to work at their own pace, supporting Gambari and Yusuf's (2014) assertion that computer-aided instructional tools help bridge learning gaps and promote active participation. Experts also confirmed that CADLT is interactive and user-friendly, enabling easy navigation, a key factor emphasized by Falode (2014) and Zaied (2007), who highlighted the significance of usability in instructional technology. Furthermore, the software's novelty in Technical Drawing education was recognized, reinforcing Bates' (2019) argument that innovative technologies play a crucial role in modern education. Overall, CADLT was seen as a valuable digital tool that not only enhances learning but also motivates students by providing an engaging and technology-driven alternative to traditional teaching methods.

Conclusion

The findings from this study provide strong evidence that CADLT software is a valuable tool for enhancing Technical Drawing education in Nigeria. Across the three research questions, expert responses consistently indicated that CADLT is a functional, accessible, and effective learning tool, though certain areas require improvement. Regarding accessibility, while experts agreed that CADLT is available for home use and functional for teaching, they expressed concerns about its readily accessible nature. This suggests that while the software exists and is beneficial, some barriers such as installation difficulties, licensing, or hardware requirements may limit its widespread use. Addressing these issues could improve its adoption among students and teachers.

In terms of individualized learning, experts agreed that CADLT meets the criteria by aligning with students' abilities, allowing them to work at their own pace, and presenting content in a clear and structured manner. The software also provides adequate support for skill acquisition and considers individual learning differences, making it a versatile educational tool for diverse learners. Finally, experts acknowledged the interactivity and user-friendliness of CADLT. The software was found to support flexible navigation, encourage learner-learner and learner-tutor interactions, and enable content engagement in technical drawing tasks. These interactive features make CADLT not only a self-paced learning tool but also a collaborative platform that fosters engagement and a deeper understanding of technical drawing concepts.

CADLT is an effective digital learning tool that enhances accessibility, promotes individualized learning, and fosters interactive learning experiences. However, improving software accessibility, enhancing collaboration features, and providing additional learner support could further optimize its effectiveness. These findings highlight CADLT's potential in revolutionizing Technical Drawing education, ultimately improving student engagement, comprehension, and skill acquisition.

Recommendation

Based on the findings, the following recommendations are made:

1. Schools should adopt innovative technologies like CADLT to enhance the teaching and learning of Technical Drawing.
2. Schools should invest in the necessary technological infrastructure, including mobile devices, computers, and trained ICT instructors who can support both teachers and students in using the software effectively.
3. Strong collaboration between software developers, curriculum designers, and educators is essential to ensure that learning tools like CADLT are aligned with students' needs and the evolving technical education curriculum.
4. By integrating technology-driven learning solutions, schools can significantly improve the quality of technical education, promote active student engagement, and prepare learners for the digital demands of modern industries.

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