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Technology-Enhanced Instruction and Learning Engagement in Electrical Trade Education: The Role of Interactive PowerPoint in Nigeria Technical Colleges

Idowu Dare, ADERINTO

Corresponding author: Idowudare36@gmail.com

[1]*Department of Industrial Technical Education Tai Solarin Federal University of Education*

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Abstract

Learning engagement is a central determinant of students' academic success and skill acquisition in vocational and technical education, particularly in practice-oriented electrical trade programmes in Nigeria technical colleges. However, instructional practices in many technical colleges remain largely traditional and teacher-centered, limiting students' active participation, motivation, and understanding of abstract electrical concepts. This theoretical article examines the potential of Interactive PowerPoint as an instructional mechanism for enhancing learning engagement among electrical trade students in Nigeria technical colleges. The discussion is anchored in the cognitive theory of multimedia learning, constructivist learning theory, and the technology acceptance model, which explain how multimedia-supported, learner-centered instruction can promote meaningful learning. Through conceptual analysis, the paper demonstrates how interactive PowerPoint presentations that integrate multimedia elements, animations, hyperlinks, and embedded learner-response activities can enhance cognitive engagement through deeper information processing, behavioural engagement through active participation, and emotional engagement by stimulating interest and motivation. This article further discusses the pedagogical relevance of interactive PowerPoint for electrical trade instruction, and clarifies the instructional roles of teachers and learners in Nigeria technical colleges. This paper would contributes to technology-enhanced technical education literature by offering a theoretically grounded framework for understanding interactive presentation tools in fostering learning engagement. Therefore, It was concluded and recommended that curriculum planners and technical education authorities should formally integrate Interactive PowerPoint and other interactive multimedia tools into electrical trade curricula as core instructional strategies.

Keywords: Interactive PowerPoint, learning engagement, Electrical trade, emotional engagement, cognitive engagement

Introduction

The rapid advancement of educational technology has significantly reshaped instructional delivery across educational systems globally, influencing how knowledge is presented, accessed, and internalized by learners. Digital technologies have enabled the integration of multimedia, interactivity, and learner-centered approaches that support deeper learning and improved educational outcomes (Mayer, 2020). In technical and vocational education and training (TVET), where the acquisition of both conceptual understanding and practical skills is fundamental, the adoption of instructional strategies that promote active learning and sustained student engagement is increasingly emphasized (Cai & Kosaka 2024).

Despite these global trends, instructional practices in many Nigeria technical colleges remain largely conventional and teacher-centered, particularly in trade subjects such as electrical installation and maintenance. Electrical trade instruction is often dominated by lecture-based approaches and chalkboard explanations, with limited use of instructional technologies that can support visualization and learner interaction (Shi et al., 2020). Such methods frequently result in passive learning environments, where students assume a receptive role, thereby limiting opportunities for active participation, inquiry, and engagement. Studies in Nigeria technical and vocational institutions have linked these traditional approaches to low student motivation, weak conceptual understanding, and poor integration of theory with practice (Kanu et al., 2024).

Learning engagement is particularly critical in electrical trade education because students are required to comprehend abstract and invisible phenomena such as current flow, circuit behaviour, and electromagnetic processes while simultaneously developing hands-on competencies needed for occupational practice. Engagement, encompassing cognitive, behavioural, and emotional dimensions, is essential for enabling learners to process complex technical content, participate actively in practical tasks, and sustain interest in learning activities (Xue, et al., 2025). When engagement is low, students may struggle to connect theoretical explanations with workshop practices, undermining the objectives of technical education.

Interactive instructional tools, such as Interactive PowerPoint, could be a means for addressing these challenges. Unlike traditional linear slide presentations, interactive PowerPoint integrates multimedia

elements such as animations, diagrams, audio, video, hyperlinks, and embedded questions that support learner interaction and active processing of information (Staneviciene & Zekienė, 2025). Besides, PowerPoint has been identified as an accessible and adaptable ICT tool capable of enriching classroom instruction when used interactively and pedagogically (Baker et al., 2018). Invariably, this may be of benefit to electrical trade education in technical colleges.

Electrical Trade Education in Nigeria Technical Colleges

Technical colleges in Nigeria constitute a core component of the nation's Technical and Vocational Education and Training (TVET) system and are primarily established to equip learners with practical skills, technical knowledge, and attitudes necessary for gainful employment and self-reliance. These institutions operate under the regulatory oversight of the National Board for Technical Education (NBTE), which prescribes minimum standards and curricula for technical trades, including electrical installation and maintenance (NBTE, 2023). The electrical trade programme is designed to prepare students for occupations such as electrical technicians, installers, and maintenance personnel across domestic, commercial, and industrial settings.

Electrical trade curricula in Nigeria technical colleges emphasize competencies such as electrical wiring, installation of electrical systems, troubleshooting and fault diagnosis, maintenance of electrical equipment, and adherence to safety regulations (Odewale et al., 2024). These competencies require a strong integration of theoretical knowledge and practical skills. However, research indicates that the intended objectives of electrical trade education are often undermined by systemic and instructional challenges that affect teaching and learning effectiveness (Eze et al., 2018).

One of the major challenges confronting electrical trade education in Nigeria technical colleges is the inadequacy of instructional resources. Many colleges lack up-to-date training equipment, instructional materials, and functional workshops that reflect modern industry standards (Ladan 2023). In addition, limited access to ICT facilities such as computers, projectors, and reliable electricity supply further constrains the adoption of innovative instructional strategies. Studies have consistently reported that these infrastructural limitations negatively affect the quality of instruction and students' learning experiences in several colleges (Yangambi 2023).

Teacher-related factors also play a significant role in shaping the instructional context of electrical trade education. Although technical teachers often possess trade-related skills, many lack sufficient training in educational technology and modern pedagogical approaches that support learner-centered instruction. As a result, instructional delivery in electrical trade subjects is frequently dominated by traditional lecture methods, with minimal integration of interactive or multimedia-based instructional tools (Bakare et al., 2024). This pedagogical pattern limits opportunities for active learning and student engagement, which are essential for effective skill acquisition in technical education.

Instruction in electrical trade subjects inherently involves complex and abstract concepts such as electric current flow, circuit behaviour, resistance, voltage regulation, and electromagnetic principles. These concepts are not easily observable and therefore require effective visualization, sequencing, and demonstration to facilitate understanding. Traditional chalk-and-talk approaches often fail to adequately represent these processes, making it difficult for students to develop accurate mental models of electrical phenomena (Singh-Pillay & Masuku 2025). Consequently, students may struggle to connect theoretical explanations with practical workshop activities, leading to superficial learning and low engagement. These outcomes are particularly problematic in electrical trade education, where sustained engagement is necessary for mastering both conceptual knowledge and hands-on skills (Orji 2025). The disconnect between instructional methods and the learning demands of electrical trade programmes highlights the need for more effective teaching strategies.

Concept of Learning Engagement

Learning engagement is a multidimensional construct that reflects the quality of students' involvement in learning processes, encompassing cognitive, behavioural, and emotional components (Wang et al., 2025). Cognitive engagement refers to the extent to which students invest mental effort in understanding content, applying learning strategies, and persisting in complex tasks to achieve mastery. It involves critical thinking, problem-solving, and metacognitive strategies that enable learners to process information meaningfully (Rivas et al., 2022). Behavioural engagement is characterized by observable participation in learning activities, including attentiveness, on-task behaviour, class attendance, and consistent completion of tasks (Xue et al., 2025). Emotional engagement involves learners' affective responses to the learning environment, such as interest, enjoyment, enthusiasm, and

positive attitudes toward educational tasks (Rusi et al., 2024). These three dimensions interact dynamically to shape overall engagement and learning outcomes.

In technical and vocational education, engagement is particularly critical because learning is not only knowledge-based but also skill-intensive. Electrical trade students, for instance, must integrate theoretical concepts such as circuit theory, current flow, and electrical safety with practical, hands-on tasks like wiring, installation, and equipment troubleshooting. Engagement influences students' ability to persist in challenging tasks, link theory with practice, and achieve higher levels of competence (Çali et al., 2024). Empirical studies indicate that students who exhibit high cognitive and behavioural engagement in vocational courses demonstrate superior problem-solving skills, greater practical proficiency, and improved retention of knowledge compared to less engaged peers (Li et al., 2023).

Instructional strategies that promote interactivity, learner autonomy, and timely feedback are known to enhance engagement. Tools such as multimedia presentations, simulations, and interactive learning platforms provide opportunities for students to actively manipulate content, test understanding, and receive immediate feedback, thereby strengthening cognitive, behavioural, and emotional engagement (Garcia et al., 2025). Specifically, in electrical trade education, engagement can be enhanced through interactive instructional materials such as step-by-step demonstrations, animations of circuits, embedded quizzes, and scenario-based learning activities, which allow learners to visualize abstract concepts and apply knowledge in simulated or real practical contexts (Awwad, 2025). The importance of engagement in vocational and technical also aligns with the Constructivist Learning Theory, which emphasizes that knowledge is actively constructed through interaction with content, peers, and the environment.

Theoretical Foundations Supporting Interactive PowerPoint

There are several theories that are key in establishing this study. However, Cognitive Theory of Multimedia Learning (CTML), Constructivist Learning and Technology Acceptance Model (TAM) are found closely related to this study.

Cognitive Theory of Multimedia Learning (CTML)

The Cognitive Theory of Multimedia Learning (CTML) posits that learners process information through two primary channels visual and auditory and that meaningful learning occurs when learners actively select, organize, and integrate information from these channels (Mayer & Moreno 2005). According to CTML, instructional materials designed to manage cognitive load can enhance understanding and retention by reducing extraneous information and focusing learners' attention on essential content (Mayer & Moreno, 2005). Interactive PowerPoint aligns closely with CTML principles because it allows the integration of text, diagrams, animations, and narration into a coherent instructional sequence. For electrical trade students, this multimodal approach enables visualization of abstract processes such as current flow, circuit connections, and system troubleshooting, which are difficult to conceptualize through traditional lecture-based methods (Wolbach et al., 2024). By allowing students to interact with dynamic representations of electrical processes, Interactive PowerPoint could foster deeper cognitive engagement, supporting the integration of theory with practice.

Constructivist Learning Theory

Constructivist Learning Theory emphasizes that learners actively construct knowledge through interaction with learning materials, peers, and prior experiences, rather than passively receiving information (Piaget, 1964). Knowledge construction is an active, iterative process where learners test hypotheses, solve problems, and reflect on their experiences. Interactive PowerPoint supports constructivist principles by offering exploratory and learner-centered experiences, such as embedded quizzes, simulations, scenario-based navigation, and hyperlinks to additional resources. In electrical trade education, students can manipulate variables in simulated circuits, engage in decision-making scenarios, and receive immediate feedback on their actions, all of which foster active learning and problem-solving (Yakkou et al., 2024).

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) provides a framework for understanding how users come to accept and utilize technology. According to TAM, perceived usefulness and perceived ease of use are key determinants of technology adoption (Davis, 1989). In the aspect of technical colleges, both

teachers' and students' perceptions of Interactive PowerPoint influence its instructional effectiveness. Teachers who perceive the technology as valuable and manageable are more likely to integrate interactive presentations into lesson delivery, provide guided exploration, and facilitate active learner engagement (Aleksieva et al., 2025). Similarly, students' perception of the usability and relevance of interactive PowerPoint affects their willingness to engage with the materials and participate actively in learning tasks. Research in vocational education has demonstrated that positive user attitudes toward multimedia technologies significantly enhance learning outcomes, motivation, and engagement in skill-based disciplines (Vaganova et al., 2020). Thus, TAM underscores the importance of teacher training, learner orientation, and institutional support for successful implementation of Interactive PowerPoint in electrical trade instruction.

Interactive PowerPoint as an Instructional Strategy

Interactive PowerPoint (IPP) refers to the pedagogical use of PowerPoint presentations that integrate interactive features, including hyperlinks, branching navigation, embedded assessments, animations, audio, video clips, and other multimedia elements (Ngwu, 2015). These features promote engagement by transforming a static presentation medium into a dynamic, learner-centered environment that aligns with contemporary instructional theories. As an instructional strategy, interactive PowerPoint goes beyond mere content presentation; it functions as a learning environment that facilitates inquiry, exploration, and problem-solving. When appropriately designed using sound instructional principles such as the Cognitive Theory of Multimedia Learning (CTML) and Constructivist Learning Theory interactive PowerPoint can enhance cognitive processing, reduce extraneous cognitive load, and foster active construction of knowledge (Mayer & Moreno 2005).

For technical and vocational education, such as electrical trade instruction in Nigeria technical colleges, IPP provides the dual benefit of supporting theoretical understanding and reinforcing practical skills through simulations, step-by-step procedural demonstrations, and scenario-based exercises (Nwineh & Okwelle 2018). Moreover, interactive PowerPoint can facilitate learner autonomy and personalized instruction. Features such as branching scenarios and navigable menus allow students to explore content according to their individual learning pace and preferences, promoting self-directed learning (Nguyen & Dao 2024).

Pedagogical Relevance in Electrical Trade Instruction

Electrical trade instruction inherently involves abstract and invisible phenomena, such as electric current, voltage fluctuations, and magnetic fields, which are not directly observable in a classroom setting. Traditional lecture-based methods and chalk-and-talk demonstrations often fail to effectively convey these complex concepts, leading to superficial understanding and reduced student engagement (Ullah & Iqbal, 2020). Interactive PowerPoint (IPP) could help to address this challenge by enabling instructors to incorporate animated diagrams, circuit simulations, procedural videos, and multimedia-rich explanations that make abstract electrical processes tangible and comprehensible (Ngwu, 2015). For example, step-by-step animations of circuit assembly or troubleshooting procedures help students follow sequential processes accurately, while embedded videos of practical demonstrations reinforce hands-on skills and contextualize theoretical knowledge (Ngonso et al., 2018).

From a pedagogical standpoint, IPP aligns with learner-centered instructional principles, which emphasize active participation, self-paced learning, and accommodation of diverse learning needs (Olugbenga, 2021). In technical colleges, students enter electrical trade programmes with varying prior knowledge, cognitive abilities, and learning preferences. Interactive features such as branching navigation, embedded quizzes, and clickable content allow learners to control the sequence, pace, and depth of their learning. This flexibility promotes autonomous learning, enabling students to review challenging concepts, repeat simulations, or attempt practice problems as needed, thereby fostering both mastery of content and confidence in practical tasks (Yea-Ru 2019).

Role of Teachers and Learners in Implementation

The successful implementation of interactive PowerPoint (IPP) in technical and vocational education depends largely on the active participation and competencies of both teachers and learners. Teachers serve as the primary facilitators of learning, responsible for designing, organizing, and delivering interactive presentations that align with pedagogical objectives (Gautam & Agarwal, 2023). Effective use of IPP requires pedagogical competence, including the ability to sequence content logically, integrate multimedia elements appropriately, and embed learner-centered activities that foster engagement and understanding (Fosnot, 2013). In addition, teachers must possess technical skills in multimedia design, including proficiency in animations, hyperlinks, quizzes, and simulations, to ensure

that the interactive components function seamlessly (Zhang & Zhu 2025). Research highlights that without adequate professional development and support, teachers may underutilize IPP features or adopt a predominantly linear, lecture-based approach, thereby limiting the potential benefits of interactivity (Ventista & Brown 2023). Continuous capacity-building programs and ICT training are therefore essential to empower teachers to design pedagogically sound and technically effective presentations that enhance cognitive, behavioural, and emotional engagement.

Learners play an equally critical role in the implementation of interactive PowerPoint. In contras to traditional instruction, IPP emphasizes active learning, requiring students to navigate slides, participate in embedded assessments, engage with simulations, and respond to scenario-based exercises (Aryan & Saman, 2024). This level of interactivity encourages learners to take ownership of their learning, develop self-regulation skills, and explore content according to individual pacing and preference (Kamran et al., 2023). In electrical trade education, learners may manipulate circuit simulations, follow procedural animations, or engage with troubleshooting scenarios, thereby linking theoretical knowledge with practical skills (Tenzin, et al., 2023). Therefore, the collaborative interplay between teachers and learners is a crucial determinant of instructional effectiveness in IPP-based lessons.

Implications for Technical Education Practice and Policy

The integration of Interactive PowerPoint into electrical trade instruction has significant implications for instructional practice, curriculum development, teacher preparation, and educational policy within Nigeria technical colleges. As technical education emphasizes the acquisition of practical skills alongside theoretical understanding, instructional strategies that promote active learning and sustained engagement are essential. Interactive PowerPoint, when designed to include animations, simulations, embedded questions, and visual demonstrations, aligns with multimedia learning theory, which posits that learning is enhanced when learners actively process information through multiple representational modes (Mayer, 2021).

From a curriculum perspective, planners should deliberately incorporate interactive multimedia strategies into electrical trade curricula as a core instructional approach rather than as an optional supplement. The use of Interactive PowerPoint can support competency-based learning by linking theoretical explanations of electrical principles to practical applications such as circuit analysis, safety

practices, and fault diagnosis. Research indicates that such interactive instructional approaches contribute to improved motivation, participation, and academic performance among technical education students compared to traditional lecture-based methods (Al Aina et al., 2020). Embedding interactive presentation tools within the curriculum can therefore enhance learner-centred instruction and better prepare students for industry-relevant skills.

The successful implementation of Interactive PowerPoint in technical colleges, however, depends largely on teachers' technological and pedagogical competencies. Teacher education programmes should incorporate structured training in instructional multimedia design and technology integration, guided by established frameworks such as the Technological Pedagogical Content Knowledge (TPACK) model (Chai et al., 2020). In view of this, the integration of Interactive PowerPoint underscores the need for sustained investment in ICT infrastructure and institutional support systems in Nigeria technical colleges. Therefore, Educational policymakers should therefore prioritize funding for ICT facilities, maintenance, and technical support, alongside policies that promote the adoption of interactive digital instructional tools in technical education. Such policy initiatives are essential for aligning technical education with national goals related to workforce development, employability, and technological advancement.

Conclusion

This study underscores the pedagogical relevance of Interactive PowerPoint as an effective mechanism for enhancing learning engagement among electrical trade students in Nigeria technical colleges. Drawing on multimedia learning theory and technology integration frameworks, Interactive PowerPoint when thoughtfully designed and pedagogically applied can promote behavioural, cognitive, and emotional engagement by facilitating active participation, visualization of abstract electrical concepts, and meaningful interaction with instructional content. Besides, interactive presentation tools would provide a valuable instructional bridge that supports deeper understanding and sustained learner involvement for electrical trade students. In essence, the study contributes to the growing body of evidence advocating for technology-enhanced instructional strategies in technical education and reinforces the need for systemic alignment between curriculum design, teacher preparation, and education policy to maximize the benefits of interactive multimedia tools.

Recommendations

Based on the existing studies and literature reviewed, the following recommendations were proposed:

1. Curriculum planners and technical education authorities should formally integrate Interactive PowerPoint and other interactive multimedia tools into electrical trade curricula as core instructional strategies.
2. Teacher education programmes should incorporate structured training in instructional multimedia design and technology integration, guided by frameworks such as Technological Pedagogical Content Knowledge (TPACK).
3. Educational policymakers should prioritize sustained investment in ICT infrastructure in technical colleges, including reliable electricity supply, adequate computer systems, multimedia equipment, and technical support services, to enable the effective use of Interactive PowerPoint and other digital instructional tools.
4. National and institutional education policies should explicitly promote the use of interactive digital instructional tools in technical education and provide incentives for innovative teaching practices that enhance student engagement and learning outcomes.

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