ASSESSMENT OF IMPACT OF DIGITAL TECHNOLOGIES ON LEARNING OUTCOMES AMONG BUILDING TECHNOLOGY STUDENTS IN FEDERAL POLYTECHNIC OFFA

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Abstract
This study assessed the impact of digital technologies on learning outcomes in Building Technology Education at Federal Polytechnic Offa, Kwara State, Nigeria. The integration of tools such as Building Information Modeling (BIM), Computer-Aided Design (CAD), Virtual Reality (VR), and Artificial Intelligence (AI) has transformed teaching and learning processes; however, empirical evidence on their influence on students' learning experiences, skill acquisition, and career preparedness remains limited. A descriptive survey research design was adopted. The sample comprised 100 Building Technology students of both Higher National Diploma (HND) and National Diploma (ND), including 25 each from ND1, ND11, HND1, and HND11, ensuring representation across levels. Data were collected using a structured 5-point Likert scale questionnaire covering frequency of use, perceived effectiveness, challenges, and career readiness. The instrument was validated and tested for reliability using Cronbach's Alpha, yielding coefficients of 0.81, 0.84, 0.79, and 0.83 across sections, indicating acceptable internal consistency. Data were analyzed using mean and standard deviation. Findings revealed that digital technologies enhance visualization, understanding, and collaboration, although challenges such as limited software access, inadequate training, and infrastructural constraints persist. The study recommends improved access and integration of digital technologies to enhance learning outcomes and industry relevance.

Keywords: Digital Tools, Building Technology Education, Building Information Modelling, Computer Aided Design, Virtual Reality, Artificial Intelligence.

Introduction

Building Technology Education (BTE) is of paramount importance in the acquisition of the necessary skills and knowledge essential for the construction and architectural sectors. This field encompasses a diverse array of subjects, including architectural design, construction techniques, materials science, and structural engineering (Emmitt & Gorse, 2014). Its principal objective is to equip students with the competence to meet both the practical and theoretical demands of the building industry. The integration of contemporary construction technologies into the curriculum has progressively gained significance to ensure the readiness of graduates to confront modern challenges in the field (Becerik-Gerber, Gerber, & Ku, 2011).

In Nigeria, the focus of building technology education has traditionally leaned towards theoretical aspects, with practical application being somewhat limited (Aina & Adio, 2019). This approach frequently results in graduates being under-prepared for the realities of the construction

sector, where hands-on experience and practical skills are essential (Okolie, Igwe, & Elom, 2019). The existing disparity between academic instruction and industry requirements underscores the necessity for an enhanced curriculum incorporating increased practical exposure and the integration of contemporary technologies (Alagbe, Aderonmu, Emetere, & Oluwatobi, 2020).

Educators and industry experts widely concur on the critical nature of advancing building technology education to elevate the quality of construction projects and bridge the industry's skills gap (Ogunyemi, 2014). The adoption of innovative teaching methods and technologies, such as virtual reality (VR) and augmented reality (AR), can furnish students with immersive learning encounters that effectively bridge the chasm between theory and application (Freina & Ott, 2015).

Digital technologies such as Building Information Modeling (BIM), Computer-Aided Design (CAD) tools, Virtual Reality (VR), Augmented Reality (AR), Internet of Things (IoT) and online learning platforms have transformed how instruction is delivered and received. These tools enable interactive and personalized learning experiences, facilitate remote access to resources, and allow for visualizations that are difficult to achieve through conventional means. Within the realm of technology-enhanced education, tools like Virtual Reality (VR), Augmented Reality (AR), and Building Information Modeling (BIM) have the capacity to establish immersive and interactive learning environments (Sacks, Perlma, & Barak, 2013). These technological advancements enable students to visualize complex structures, engage in virtual site visits, and collaborate on design projects in real-time, thereby offering a more experiential learning approach (Abulrub, Attridge, & Williams, 2011). Virtual Reality (VR) and Augmented Reality (AR) play a pivotal role in enriching the learning journey by granting students the opportunity to engage with 3D models, simulate construction procedures, and explore virtual settings (Freina & Ott, 2015). These technologies render abstract concepts more tangible and comprehensible, ultimately enhancing understanding and memory retention (Pantelidis, 2010).

In Addition, Building Information Modeling (BIM) stands out as another indispensable technological tool that can revolutionize the realm of building technology education. BIM revolves around generating and overseeing digital representations of both the physical and functional attributes of spaces. It empowers students to work with detailed and comprehensive digital models of construction ventures, thereby fostering improved comprehension and collaboration (Sacks et al., 2013). The architecture, Engineering and Construction (AEC) industry is undergoing a digital revolution, driven by advancements in BIM, VR/AR, AI and IoT. These technologies are increasingly embedded in academic curricula to bridge the gap between theoretical knowledge and industry practices. However, the effectiveness of these tools in enhancing student learning outcomes including technical competency, design proficiency and collaborative skills.

Learning outcomes are defined as the knowledge, skills, attitudes, and values that students are expected to acquire through their engagement with a higher education program (Biggs & Tang, 2011). The significance of learning outcomes lies not only in their role as indicators of educational quality but also in their capacity to guide curriculum design, teaching, and assessment practices. In the context of higher education, learning outcomes have become a focal point for policy makers, educators, and researchers alike, as they seek to respond to the demands of a rapidly changing global economy and society. Recent research has highlighted the positive impact of educational technology on learning outcomes. For instance, Criollo-C, González-Rodríguez, Guerrero-Arias, Urquiza-Aguiar, and Luján-Mora, (2023) explore the acceptance and use of emerging technologies (ETs) in higher education, demonstrating that technologies such as augmented reality, virtual reality, and mobile learning can notably add to educational processes and outcomes. These technologies offer immersive learning experiences that promote greater application of knowledge and student motivation, thereby contributing to improved learning outcomes (Criollo-C et al., 2023).

Furthermore, the role of technology-supported education in enhancing student learning outcomes has been substantiated. They found out that students utilizing technology-supported tools exhibit higher levels of learning, improved attitudes towards learning, and increased engagement and motivation. This evidence underscores the potential of educational technology to positively influence learning outcomes across various educational settings, including higher education. However, there are several limitation and challenges to their effective adoption such as limited access to digital resources, inadequate provision of the digital tools. The need for further research work is needed to assess the impact of digital technologies on learning outcomes among building technology students in Federal Polytechnic Offa, Kwara State education focusing on their perceived effectiveness.

Statement of the Problem

The integration of digital technologies into building technology education has increased significantly in recent years. Digital tools like Virtual Reality (VR), Augmented Reality (AR), and Building Information Modeling (BIM) have the capacity to establish immersive and interactive learning environments (Sacks et al., 2013). However, there are limited empirical evidences showing the extent to which these digital tools actually improve learning outcomes in Building Technology programmes.

Despite considerable investments in digital infrastructure and training, concerns persist about whether the adoption of these technologies translates into measurable academic improvement. Some students may struggle with access to devices, internet connectivity, or adequate technical support, which can affect their ability to fully benefit from digital learning tools.

Furthermore, many existing studies focus primarily on technological implementation rather than students lived experiences and perception. There is insufficient understanding of how students in building technology education perceive the effectiveness, accessibility and challenges associated with digital technologies in their learning process. Therefore, it becomes vital to assess the impact of digital technologies on learning outcomes from the students' perspective in order to provide evidence-based recommendations for improving teaching and learning practices.

Significance of the Study

This study will be significant to students of building technology education as it will provide insight into how digital technologies influence their academic performance and practical skill acquisition. By examining their perspectives, the research will highlight the benefits and challenges associated with the use of tools such as AutoCAD and Revit, thereby helping to improve their learning experience.

In addition, the study will also be valuable to lecturers and instructors in building technology programmes, as it will provide evidence-based information on the effectiveness of integrating digital technologies into teaching. The findings can guide educators in adopting appropriate instructional strategies that enhance students' understanding of building construction concepts and technical competencies.

Furthermore, the research will be beneficial to educational administrators and policymakers by providing data that can inform decisions regarding investment in curriculum development, digital infrastructure, and training. It will contribute to existing literature on technology-enhanced learning and serve as a reference for future researchers interested in digital innovation within technical and vocational education.

Purpose of the Study

The purpose of the study was to investigate the impact of digital technologies on learning outcomes in Building Technology Education. Where specifically, the objectives of the study were to:

1. Examine the extent to which digital technologies are integrated into the teaching and

learning of Building Technology Education.

2. Evaluate students' perceptions of the effectiveness of digital technologies in enhancing their understanding of Building construction concepts.
3. Identify the challenges students face in using digital technologies for learning in building technology programmes.

Research Questions

The following three research questions were formulated to guide the study

1. To what extent are digital technologies integrated into teaching and learning in Building Technology Education?
2. What are students' perceptions of the effectiveness of digital technologies in enhancing their understanding of building construction concepts?
3. What challenges do students face in the use of digital technologies for learning in Building Technology Education?

Research Methodology

This study adopted a descriptive survey research design with a quantitative approach. The design was appropriate for assessing the students' perception on the impact of digital technologies on their learning outcome in Building Technology Education. The target population comprised of both Higher National Diploma (HND) and National Diploma (ND) students of Federal Polytechnic Offa, Kwara State. A stratified random sample technique was used to ensure representation across all the level of Building Technology students. Adopting a descriptive survey design, the research utilized a 26-item questionnaire administered to students in Federal Polytechnics Offa, comprising 100 respondents. A well-developed questionnaire titled "Impact of Digital Technologies on Learning Outcomes in Building Technology Education" (IDTLOBTE) convening 26 items questions. The instruments were validated by 3 lecturers, two from Federal College of Education (Technical) Ekiadolor and one from Federal Polytechnic Offa. Reliability was established using Cronbach's alpha, yielding coefficients of 0.81, 0.84, 0.79, and 0.83 across sections, indicating acceptable internal consistency. Research questions were analyzed using mean and standard deviation was carried out with statistical package for social science version 26 (SPSS).

Results

Research question 1

Research question 1 state that to what extent are digital technologies integrated into teaching and learning in Building Technology Education?

Table 1: Mean Response and Standard Deviation of the Extent Digital Technologies are Integrated into Teaching and Learning in Building Technology Education

S/N	Items Statement	X	SD	Decision
1.	Digital technologies are regularly used during lectures in building technology courses	1.75	0.74	Disagree
2.	My lecturers use multimedia presentations (e.g. PowerPoint) to teach building construction concepts	1.84	0.68	Disagree
3.	Learning Management Systems (Google classroom) are used to share course materials	1.49	0.73	Disagree
4.	Online resources (Videos, simulation, e-books) are incorporated into teaching	1.52	0.77	Disagree
5.	Computer-aided design (CAD) software is used during practical sessions	3.78	0.68	Agree
6.	Virtual simulations are used to demonstrate construction processes	1.64	0.69	Disagree
7.	Assignments are submitted through digital platforms	1.70	0.81	Disagree
8.	Online assessments or quizzes are conducted in my department	1.48	0.71	Disagree
9.	Digital tools are used for collaborative learning (e.g. group projects online)	1.37	0.73	Disagree
10.	Digital technologies are effectively blended with traditional teaching methods	1.54	0.67	Disagree
	Grand Total	**1.81**	**0.72**	**Disagree**

The result presented in Table 1 reveal a general disagreement among respondents regarding the integration of digital technologies into Building Technology Education with a low mean score of 1.81, below the acceptable benchmark of 2.50. The standard deviation of 0.72 indicates that most respondents shared similar views. This indicates a clear and consistent concern. Digital technologies such as VR, AR, BIM, and AI integration are to a low extent in teaching and learning Building Technology Education in Federal Polytechnic Offa, Kwara State.

Research Question 2

Research question 2 state that what are students' perceptions of the effectiveness of digital technologies in enhancing their understanding of building construction concepts?

Table 2: Mean Response and Standard Deviation on Students' Perception of the Effectiveness of Digital Technologies in Enhancing their Understanding of Building Construction Concepts

S/N	Items Statement	X	SD	Decision
1.	Digital technologies improve my understanding of building construction principles	3.42	0.71	Agree
2.	The use of videos and animations makes construction processes clearer	3.78	0.65	Agree
3.	CAD software enhances my ability to visualize building design	4.61	0.70	Agree
4.	Digital learning tools increase my interest in building technology courses.	4.34	0.66	Agree
5.	Technology-based learning improves my academic performance	3.98	0.78	Agree
6.	Digital simulation helps me understand practical construction procedures better	4.05	0.72	Agree
7.	I feel more confident using digital tools for academic tasks	3.76	0.62	Agree
8.	Digital technologies make complex building concepts easier to understand	4.01	0.69	Agree
9.	Overall, digital technologies enhance the quality of my learning experience	3.91	0.80	Agree
	Grand Total	**3.98**	**0.70**	**Agree**

Table 2 reveal a high mean score of 3.98 with a standard deviation of 0.70, indicating strong agreement among respondents that digital technologies are having a positive effect on digital technologies in enhancing their understanding of building construction concepts. Digital tools such as BIM, AR, VR, AI and other digital media were recognized for improving both theoretical understanding and practical application. The consistency in responses suggests a shared belief that integration of these digital technologies is effective in enhancing the students understanding of building construction concepts.

Research Question 3

Research question 3 state that what challenges do students face in the use of digital technologies for learning in Building Technology Education?

Table 3: **Mean and standard deviation response on the challenges students face in the use of digital technologies for learning in Building Technology Education.**

S/N	Items Statement	X	SD	Decision
1.	I do not have adequate access to digital devices for my studies	3.51	0.63	Agree
2.	Power supply issues affect my ability to use digital technologies	3.84	0.65	Agree
3.	I experience poor internet connectivity when using digital learning tools	3.87	0.67	Agree
4.	Technical problem (software errors, system crashes) disrupts my learning	2.89	0.70	Agree
5.	I find some digital technologies complex and difficult to learn	3.21	0.68	Agree
6.	Some lecturers are not proficient in using digital technologies for teaching	4.12	0.71	Agree
7.	There are insufficient digital facilities in my department	4.25	0.75	Agree
	Grand Total	**3.67**	**0.68**	**Agree**

Table 3: Revealed the challenges face by the students with the use of digital technologies for learning building technology education. The item 1-7 has a mean range of 4.25 to 2.89, and the grand mean as 3.67, this implies that, the respondents agreed on the item 1-7 on the challenges facing the use of digital technologies for learning Building Technology Education. The standard deviation of the items also ranged from 0.75- 0.63, with grand SD as 0.68. This implies that the responses were close to one another in opinions.

Discussion of Findings

Table 1 indicates that the overall integration of digital technologies such as BIM, AI, VR, AR and digital platforms remains low, with a grand mean score of 1.81, well below the benchmark of 2.50. The standard deviation of 0.72 shows a consistent view among respondents. This suggests a shared concern among students that digital technologies are not yet fully integrated in teaching and learning in Building Technology Education.

Table 2 presents strong agreement on the effectiveness of digital technologies where they have been adopted. With a mean score of 3.98 and a standard deviation of 0.70, respondents agreed that tools like CAD software, BIM, VR, AR, and online platforms significantly enhance their understanding of building construction concepts. These findings support previous research by Kwiatek, Sharif, Li, Haas, & Walbridge, (2019), Agrawal and Pillai (2020), and Lavrentieva, Arkhypov, Kuchma, & Uchitel, (2020), who found that immersive technologies improve learner engagement, accuracy, and real-world readiness. It also supports the findings of Hamutoglu, Gemikonakli, Duman, Kirksekiz, and kiyici (2019) that identified that VR, AR technologies offer immersive and interactive learning experiences allowing students to explore virtual environment, simulate real-world scenarios and visualize complex concepts. It also agreed with findings of Montebello (2018) that enhances of these technologies enhances engagement, retention and understanding of subject matter across various disciplines.

Table 3 highlights persistent challenges the students face in the use of digital technologies in learning in Building Technology Education such as insufficient access to digital infrastructure, lecturer's limited digital competence, power supply issues, high internet costs, and insufficient digital facilities provided by the institution. This corroborates prior studies that have studied have identified systemic challenges in Nigeria's educational and digital infrastructure, particularly in higher education setting (Oyekunle, Gbanga-Julius, & Adeeko, 2024; Okon, Egbai, & Uzoigwe, 2025). Access to devices like computers, projectors, printers is often limited with a low computer to students' ratio further reducing instructional efficiency (Johnson, White, & Smith, 2016; Ajiboye, 2020)

Conclusion

The study examined the impact of digital technologies on learning outcomes in Building Technology Education from the perspective of students in Federal Polytechnic Offa, Kwara State. The findings revealed that the integration of digital technologies in the teaching and learning of Building Technology remains relatively low despite the increasing importance of digital tools in the construction industry. Most respondents indicated that digital tools such as online assessments, and multimedia teaching resources are rarely utilized in their courses, with Computer-Aided Design (CAD) being one of the few technologies moderately used during practical sessions.

Despite the limited integration, the study further revealed that students strongly perceive digital technologies as highly effective in improving their understanding of building construction concepts. Tools such as CAD, BIM, VR, AR, and digital simulations were acknowledged to enhance visualization, increase engagement, simplify complex concepts, and improve academic performance. This indicates that when properly integrated into the curriculum, digital technologies have significant potential to improve learning outcomes and better prepare students for professional practice in the construction industry.

However, the study also identified several challenges that hinder the effective adoption of digital technologies in Building Technology Education. These include inadequate access to digital devices, unstable power supply, poor internet connectivity, limited digital infrastructure, high internet costs, and insufficient digital competence among some lecturers. These challenges significantly limit students' ability to fully benefit from technology-enhanced learning.

In conclusion, although digital technologies possess strong potential to enhance learning outcomes in Building Technology Education, their effectiveness is currently constrained by limited integration and infrastructural challenges. Addressing these barriers is essential to fully leverage digital technologies for improving teaching, learning, and professional readiness in the Building Technology discipline.

Recommendations

In light of the findings, the following recommendations were proposed:

1. **Increased Integration of Digital Technologies**: Institutions offering Building Technology programmes should deliberately integrate digital technologies such as BIM, VR, AR, and CAD into teaching and learning processes to enhance students' understanding of construction concepts and practical skills.
2. **Provision of Adequate Digital Infrastructure**: Educational administrators and government agencies should invest in modern digital facilities such as computer laboratories, simulation software, projectors, and high-speed internet to support technology-based learning.
3. **Capacity Building for Lecturers**: Regular training and professional development programmes should be organized for lecturers to improve their competence in the use of digital technologies for teaching and learning.
4. **Improvement of Power Supply and Internet Access**: Institutions should provide alternative power sources such as solar energy systems and improve internet connectivity to ensure uninterrupted access to digital learning tools.
5. **Curriculum Review and Industry Collaboration**: The Building Technology curriculum should be periodically reviewed to incorporate emerging technologies used in the Architecture, Engineering, and Construction (AEC) industry, ensuring that graduates possess industry-relevant digital competencies.
6. **Improved Access to Digital Devices for Students**: Institutions should explore partnerships with government agencies and private organizations to provide affordable digital devices and licensed software to students to facilitate technology-enhanced learning.

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