Development and Evaluation of Module for Teaching Building Information Modelling to Technical Education Students in Nigerian Universities

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Abstract

Building Information Modelling is a digital process and methodology used in the architecture, engineering, and construction industries to create and manage a comprehensive and collaborative building or infrastructure project. This digital representation, often in the form of a 3D model, contains detailed information about the project's physical and functional characteristics. This study developed and validated Building Information Modelling instructional module for teaching Technical Education students in Nigerian Universities. Four research questions guided the study. Survey research design were adopted for the study. The population of the study was all technical education lecturers in Nigerian Universities. Thirty-six technical education lecturers in Technical Education Department in Ebonyi State University, University of Benin and University of Nigeria were selected by simple random sampling technique and used for the study. A 79-item instrument titled Development and Evaluation of Module for Teaching BIM to Technical Education Students in Nigerian Universities was developed as Checklist. The instrument was faced validated by five experts. Cronbach alpha statistics was used to establish the reliability coefficient of the instrument which gave values of .86, .73 and .82 respectively for the three clusters of the instrument. The research questions were analyzed using Mean and standard deviation. Findings of the study revealed that the contents, specific objectives, instructional methods, materials and evaluation techniques of the developed Building Information Modelling instructional module are highly appropriate for teaching students in the Department of Technical Education in Nigerian Universities. The study recommended among others that the National Commission for Universities should adopt the developed BIM instructional module for teaching the students in Nigerian Universities.

***Keywords**: Development, Evaluation, Building Information Management, Technical Education, Universities*

Introduction

University education, also commonly referred to as higher or tertiary education, is a form of advanced learning that takes place at universities or colleges after an individual has completed secondary education. Ikpesu and Appah (2021) stated that University education is a vital stage of learning that involves in-depth study of specialized subjects and provides students with the opportunity to develop advanced skills, critical thinking abilities, and expertise in their chosen fields, while also contributing to the advancement of society through research and innovation. With a rich history dating back to the colonial era, Nigerian University education is a critical phase of learning that offers students with a wide range of degree programmes, including bachelor's, master's, and doctoral degrees in humanities, sciences, social sciences, engineering, business, arts, and more for gainful employment or self-reliance in an occupation (FRN, 2013; Abolo, 2019; Jimoh, et al., 2020). In Nigeria, universities offer Technical Education programme in various fields of specializations including Automobiles, Mechanical and Metalwork Technology, Electrical/Electronic Technology, Building, Computer System Maintenance and Woodwork Technology (FRN, 2013; Ayonmike & Okeke, 2015; Auta, 2017; Ayonmike, 2020; Owo & Deebom, 2020). Edokpolor and Owenvbiugie (2017), Oladejo (2019) and Danladi, et al. (2020) posited that technical education in Nigerian universities offer a pathway for individuals who want to pursue careers that demand specialized skills and technical proficiency, ensuring graduates are well-equipped to meet the demands of their chosen industries.

A pertinent issue in technical education has been the nexus between what is taught in schools and the skills required for practice. Mohammed and Ahmad (2017) asserted that construction industries are faced with the need to innovatively integrate technical education graduates the construction process and address project development challenges. The construction industry is undergoing a radical change as project owners are demanding for more project visibility at lower cost and better risk management; this has increased the use of new technologies in project implementations (Ogwueleka & Ikediashi 2017). Stakeholders in construction industries have directed their energies toward establishing a suitable, sustainable and efficient system to enhance the global competitiveness of the construction sector. According to Bui, Merschbrock and Munkvold (2016), the collective drive has given rise to the development of a computerized tool known as Building Information Modeling (BIM). BIM is a cutting-edge technology that has addressed prominent challenges in the Architecture, Engineering and Construction industries in most of the developed countries (Sahil 2016; Onungwa, Uduma-olugu & Igwe, 2017). Abdullahi and Ibrahim (2016) assert that BIM was developed as a response to the limitations of traditional Computer-Aided Drawing (CAD) systems. Maina (2018) and Opoko, et al., (2019), defined BIM as a digital representation of the physical and functional characteristics of a building or infrastructure, which offers numerous benefits, including improved project collaboration, reduced errors, enhanced decision-making, presenting the potential to revolutionize the construction industry. Kushwaha (2016) maintained that BIM offers a functional digital platform that seamlessly integrates crucial building details into an electronic repository, which is accessed by diverse project stakeholders. According to Matarneh and Hamed (2017), Al-Ashmori, et al. (2020), Emmanuel-Eze, Ugulu, and Egwunatum (2021), the advantages of adopting Building Information Modelling (BIM) include the ability to provide accurate time and cost estimations for design alterations, heightened productivity and operational efficiency, the elimination of conflicts within designs, improved and synchronized communication among multiple parties, identification of temporal clashes, integration of scheduling and planning for construction activities, and effective monitoring and tracking of construction advancements.

The progression brings a comprehensive revolution by facilitating the transition of a construction project from traditional manual design and drafting methods to 2D computer-aided design (CAD), 3D modeling, and the current dynamic phase of intelligent BIM (Hamma-Adama, Kouider, & Salman, 2018). The growing need for Building Information Modeling (BIM) integration in the construction sector has led several universities worldwide to either revise their current courses with BIM education or establish distinct courses dedicated to BIM education (Abbas et al., 2016; Abdirad & Dossick, 2016). Lee and Hollar (2013) and Abdirad and Dossick (2016), noted that the integration of BIM education not only reduces costs associated with BIM implementation within organizations but also enhances the career prospects of university graduates. Maina (2018) emphasized that students are increasingly recognizing the significance of BIM applications in their future professional endeavors, although this awareness has been developing without a structured curricular framework. McDonald and Donohoe (2013) suggested that BIM education equips students to address emerging occupational challenges with heightened efficiency. Amarnath, Chang and Hsieh (2016), Yusuf, Ali & Embi (2016) asserted that students should acquire foundational knowledge in BIM technology, given its innovative nature and growing relevance in design practices.

Despite the driving forces and benefits linked to Building Information modeling (BIM), several obstacles continue to impede its widespread adoption in educational system particularly in Nigeria where BIM adoption remains strikingly low Maina (2018). While technology is advancing and more countries are embracing the use of BIM in construction, Kouider, Salman and Salman (2018), Mohammed, Hasnain, and Quadir (2019), Babatunde, Udeaja, and Adekunle (2020) have identified significant barriers to BIM adoption, including personal attitudes toward BIM integration, resistance to new technologies among employees, concerns about untested methods, challenges related to data interoperability and compatibility of digital design information, limited staff training, high costs of BIM software and hardware, as well as complexities and accessibility issues with BIM tools.

To ensure the effectiveness of TVET programs in preparing graduates for significant contributions to national development, it is imperative to address the challenges highlighted. Peck (2018) underscored the crucial role of instructional modules in equipping students with the necessary skills for successful teamwork, adaptability, flexibility, and self-confidence, positioning them for success in both present and future contexts. Ekhator (2013) and George (2022) emphasized that learning involves a structured knowledge foundation in instructional methods, materials, and evaluation techniques. Ekhator (2013) further emphasized that developing an instructional module entails a multifaceted and often integrative process that significantly contributes to the module's success. Alshahad (2013) outlined the steps involved in module development, including identifying the target audience, listing the tasks to be undertaken, identifying essential knowledge and skills, selecting teachable knowledge and skills alongside training objectives, structuring the chosen components into a cohesive and teachable module, and creating comprehensive outlines comprising instructional objectives, core content, teaching methods, illustrative examples, and exercises. Similarly, Ombugus (2013) opined that the process also involves seeking input from experts to enhance the exercises and content, creating the instructional package along with facilitator guidelines, and conducting field tests on the instructional module, followed by subsequent improvements guided by feedback from the field tests. Therefore, this research focuses on the development of a BIM instructional module tailored for teaching Technical Education students in universities in the South East region of Nigeria.

Statement of the Problem

Building Information Modeling (BIM) is fast gaining application among companies in Nigeria. More and more companies are adopting BIM especially for large scale collaborative projects. However, Oladiran, Simeon and Anyira (2022) maintained that the adoption of BIM is hampered by issues of awareness, skills and adaptation. Very few companies and individuals are versed enough to utilize BIM. More worrisome to stakeholders has been the fact that some collaborative units have stalled projects because of their lack of BIM skills. This has shifted the focus to higher education institutions to rise up to the challenge of training BIM compliant graduates.

According to Maina (2018) and Opoko, et al., (2019), one significant challenge impeding the widespread integration of BIM in Technical Education in Nigerian universities is the absence of instructional modules or courses on BIM in the Technical Education curriculum, which fails to meet the evolving requirements of the construction industry. This gap leads to inefficiencies, decreased productivity, and increased project costs, as the workforce is inadequately prepared to leverage the potential benefits of BIM. Consequently, graduates enter the workforce without the necessary knowledge and skills in this transformative technology. Therefore, there is an urgent need to address the gap in BIM education for Technical Education students in Nigerian universities. Consequently, this research focuses on the development of a BIM instructional module tailored for teaching Technical Education students in universities in the South East region of Nigeria.

Purpose of the Study

The objective was to develop and validate BIM instructional module for teaching Technical Education students in Universities in South East Nigeria. Specifically, the study seeks to:

1. determine the contents considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students.
2. determine the specific objectives, instructional methods, materials and evaluation techniques considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students.
3. validate the instructional module for teaching BIM to Technical Education students.
4. try-out the BIM instructional module on Technical Education students taught with the module and students taught without the module.

Research Questions

1. What are the contents considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN?
2. What are the specific objectives, instructional methods, materials and evaluation techniques considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN?
3. How valid is the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN?
4. To what extent are Technical Education students taught with the instructional module and students taught without the instructional module understand BIM in EBSU, UNIBEN and UNN?

METHODOLOGY

The study adopted Research and Development (R&D) design. The choice of R&D was suitable for the study according to Alshahad's (2013) who defined R&D, as involving the utilization of research methodologies to design novel products and procedures. These processes are then field-tested, evaluated, and refined iteratively until they satisfy specific criteria related to effectiveness, quality, or similar standards. The study was conducted in Ebonyi State University (EBSU), University of Benin (UNIBEN), Edo State and University of Nigeria, Nsukka (UNN), Enugu State situated in the South East geopolitical zone of Nigeria. The study population comprised of 54 lecturers and 97 final year students from Ebonyi State University (EBSU), University of Benin (UNIBEN), Edo State and University of Nigeria, Nsukka (UNN), Enugu State, Nigeria. Simple random sampling technique was used to select 36 lecturers and 60 final year students in Technical Education Department in Ebonyi State University (EBSU), University of Benin (UNIBEN), and University of Nigeria, Nsukka (UNN).

The study developed a 79-item instrument titled: Development and Evaluation of Module for Teaching BIM to Technical Education Students in Nigerian Universities as Checklist for data collection. The instrument was developed to ascertain the content of a BIM course for TVET students. The instrument contained specific objectives, instructional methods, materials, evaluation techniques suitable for assessment for BIM and try-out BIM instructional module on Technical Education students taught with the developed module and students taught without the module. The developed instrument was designed with a five-point rating scale of Very Highly Appropriate (4.50-5.00), Highly Appropriate (HA=3.50-4.49), Moderately Appropriate (MA=2.50-3.49), Lowly Appropriate (LA=1.50-2.49) and Not Appropriate (NA=1.00-1.49) provided for the respondents to make their responses in research questions 1.and 2 while Strongly Agreed (SA=4.50-5.00), Agreed (A=3.50-4.49), Moderately Agreed (MA=2.50-3.49), Undecided (U=1.50-2.49), Strongly Disagreed (SD=1.00-1.49) was provided for the respondents to make their responses in research questions 3 and 4. The instrument was faced validated by five experts in Industrial Technology Education and Test and Measurement from the University of Uyo, Akwa Ibom State. The content validity of the instrument was qualitatively and quantitatively ascertained. The qualitative content validity involved experts in Delphi technique assessing the instrument in terms of covering the objectives and content of training in BIM. It also ensures that the proposed BIM training was appropriate for the level of study. The quantitative content validity was ascertained through Lawshe content validity. After the instrument was reviewed, the experts now rated the instrument. The Lawshe content validity ratio gave a value of .71, indicating a very high content validity. To ensure instrument reliability, Cronbach's Alpha statistics were employed, resulting in a reliability coefficient of .86, .73 and .82 which shows the instrument was reliable for the study.

The researchers administered the questionnaire directly to the respondents in the Universities with the help of three research assistants in the Universities. The instrument was collected immediately after completion which recorded 95% return rate. The data collected were analyzed using mean and standard deviation to answer the research questions. The analysis was done using Statistical Package for Social Sciences (SPSS).

RESULTS

Research Question 1: What are the contents considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN?

Table 1: *The contents considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN.*

S/N	Item Statement: Contents considered appropriate for teaching BIM to Technical Education students	EBSU(N=12) $\bar{x}$	SD	UNIBEN(N=12) $\bar{x}$	SD	UNN(N=12) $\bar{x}$	SD
1.	History and evolution of BIM	4.28	0.69	3.92	0.63	4.15	0.71
2.	Principles and concepts of BIM	4.41	0.64	4.05	0.44	3.84	0.68
3.	Benefits and challenges of BIM adoption	4.15	0.67	4.66	0.59	3.77	0.49
4.	BIM software tools and their features (e.g., Revit, ArchiCAD, BIM 360).	3.83	0.59	4.18	0.81	4.15	0.69
5.	Collaborative and cloud-based BIM platforms	4.22	0.72	4.02	0.68	4.36	0.63
6.	Parametric modeling techniques	4.18	0.68	3.73	0.77	4.09	0.70
7.	Data structure and information hierarchy in BIM	3.74	0.61	4.36	0.71	3.73	0.55
8.	BIM data standards (e.g., IFC, COBie)	4.47	0.76	4.11	0.63	3.91	0.92
9.	Data integration and exchange	3.75	0.70	3.93	0.72	3.69	0.78
10.	Clash detection and resolution	4.10	0.74	3.62	0.57	4.17	0.64
11.	Collaborative design and model sharing	3.64	0.65	4.15	0.60	4.06	0.93
12.	BIM project collaboration platforms	4.19	0.63	3.58	0.66	3.81	0.66
13.	Design visualization and rendering	4.32	0.58	4.14	0.61	3.48	0.84
14.	Analysis and simulation using BIM	3.82	0.73	3.61	0.59	4.14	0.69
15.	Construction phasing and scheduling with BIM	4.38	0.66	3.52	0.87	3.73	0.83
16.	Quantity takeoff and cost estimation	4.46	0.78	4.07	0.79	3.88	0.59
17.	Construction documentation and coordination	4.07	0.69	3.94	0.74	4.19	0.47
18.	BIM for facility maintenance and operations	4.31	0.89	4.24	0.48	3.67	0.72
19.	Asset management and life cycle analysis	4.11	0.94	3.83	0.78	4.01	0.51
20.	Building performance monitoring	3.84	0.66	3.88	0.49	4.13	0.49
	Grand Mean and Standard Deviation	**4.11**	**0.70**	**3.98**	**0.66**	**3.95**	**0.68**

NOTE: Highly Appropriate (HA=3.50-4.49), Moderately Appropriate (MA=2.50-3.49)

The analyzed data in Table 1 revealed that grand mean and standard deviation of 4.11(0.70), 3.98(0.66) and 3.95(0.68) on the contents considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN. The result indicates that the contents are highly appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN in South East geopolitical zone, Nigeria.

Research Question 2: What are the specific objectives, instructional methods, materials and evaluation techniques considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN?

Table 2: *The specific objectives, instructional methods, materials and evaluation techniques considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN.*

S/N	**Item Statement A: Specific Objectives of BIM** On completion of this module, the student should be able to:	EBSU(N=12) $\bar{x}$	SD	UNIBEN(N=12) $\bar{x}$	SD	UNN(N=12) $\bar{x}$	SD
1.	Familiarize with BIM software interfaces (e.g., Revit, ArchiCAD, AutoCAD) and basic navigation	4.43	0.72	4.11	0.66	3.91	0.81
2.	Understand building 3D architectural, structural, and MEP models using BIM software	3.55	0.76	4.02	0.73	4.13	0.54
3.	Create parametric components and families for intelligent modeling	4.27	0.73	4.36	0.58	4.48	0.72

4.	Understand how to use and customize BIM object libraries and content libraries for efficient modeling.	4.19	0.69	3.95	0.50	4.36	0.63
5.	Detect and resolve clashes and coordination issues within BIM models	3.76	0.74	4.31	0.39	3.72	0.95
6.	Collaborative with BIM workflows, including model sharing, version control, and collaborative platforms like BIM 360	4.42	0.68	3.88	0.47	4.05	0.91
7.	Create construction documents such as plans, sections, elevations, and schedules directly from BIM models	3.87	0.51	3.45	0.42	4.18	0.66
8.	Use BIM data to perform quantity takeoffs and generate cost estimates for construction projects	4.11	0.63	3.49	0.61	3.74	0.74
9.	Produce realistic renderings and visualizations from BIM models for presentations and design reviews	3.49	0.77	4.01	0.70	3.06	0.79
10.	Set up project templates, and organizing project data	3.28	0.69	4.17	0.66	4.27	0.82
11.	Apply BIM for sustainable design and energy analysis, including simulation tools.	3.94	0.36	3.52	0.53	3.85	0.65
12.	Use BIM for facilities management, asset tracking, and maintenance planning	4.21	0.54	4.26	0.44	4.22	0.55
	Total	**3.96**	**0.65**	**3.96**	**0.56**	**4.00**	**0.73**
	Item Statement B: Instructional Methods of the Module						
1.	Use Demonstration Method	4.05	0.75	3.64	0.62	4.23	0.44
2.	Use Teacher/Student Participatory/Interactive Method	4.11	0.71	4.38	0.77	4.14	0.63
3.	Use Case Study Method	3.26	0.58	4.41	0.69	3.88	0.58
4.	Use lecture method.	4.08	0.77	4.33	0.57	3.49	0.79
5.	Use problem solving method.	4.14	0.60	3.62	0.85	4.24	0.66
	Total	**3.93**	**0.68**	**4.08**	**0.70**	**4.00**	**0.62**
	Item Statement C: Instructional materials/facilities of the module						
1.	Case studies/Text books/Journals.	3.59	0.66	4.11	0.63	4.36	0.84
2.	Multimedia Projector.	3.72	0.57	4.19	0.84	4.15	0.92
3.	Interaction Whiteboard/Electronic Class Roll.	4.18	0.68	3.84	0.42	3.60	0.38
4.	Google Classroom.	4.07	0.63	3.81	0.43	3.75	0.68
5.	Desktop/Laptop Computer.	3.83	0.69	4.25	0.69	4.32	0.56
	Total	**3.88**	**0.65**	**4.04**	**0.60**	**4.04**	**0.68**
	Item Statement D: Evaluation techniques of the module						
1.	Ipsative Evaluation.	4.37	0.65	4.21	0.67	4.38	0.79
2.	Criterion-referenced Evaluation.	4.10	0.62	3.63	0.16	4.13	0.47
3.	Norm-referenced Evaluation.	4.24	0.71	4.18	0.55	3.82	0.95
4.	Formative Evaluation.	3.76	0.64	4.29	0.41	3.09	0.81
5.	Summative Evaluation.	4.12	0.66	4.08	0.45	3.86	0.76
	Total	**4.37**	**0.65**	**4.21**	**0.67**	**4.38**	**0.79**
	Grand Mean and Standard Deviation	**4.04**	**0.66**	**4.07**	**0.63**	**4.11**	**0.71**

NOTE: Highly Appropriate (HA=3.50-4.49), Moderately Appropriate (MA=2.50-3.49)

The analyzed data in Table 2 shows grand mean and standard deviation of 4.04(0.66), 4.07(0.63) and 4.11(0.71) on the objectives, methods, materials and evaluation techniques considered appropriate for inclusion in the instructional module for teaching in EBSU, UNIBEN and UNN. The result indicates that the objectives, methods, materials and evaluation techniques are highly appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN in South East geopolitical zone, Nigeria.

Research Question 3: How valid is the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN?

Table 3: *Validity of the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN.*

S/N	Item Statement A. The content of the BIM modules	EBSU(N=12)		UNIBEN(N=12)		UNN(N=12)	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
1.	Gives a clear idea of how much to plan and teach each topic.	4.49	0.67	3.54	0.59	3.66	0.62
2.	Is simple and easy to understand.	3.52	0.73	4.33	0.54	4.32	0.50
3.	Are fully discussed.	4.48	0.76	4.12	0.63	4.09	0.66
4.	Is appropriate for the level of the students.	4.45	0.74	4.16	0.73	4.11	0.39
5.	Gives equal emphasis in the lessons.	3.73	0.69	3.44	0.66	4.17	0.71
	Item Total	**4.13**	**0.72**	**3.92**	**0.63**	**4.07**	**0.58**
	Item Statement B. The Objectives of the modules						
1.	Are clearly stated in behavioral form.	3.44	0.71	3.63	0.70	3.28	0.67
2.	Are well-planned, formulated and organized.	4.31	0.75	3.84	0.64	4.16	0.44
3.	Are specific, measurable and attainable.	3.89	0.64	4.12	0.39	4.03	0.53
4.	Are relevant to the topics of each lesson of the modules.	3.66	0.68	4.23	0.47	3.39	0.61
5.	Take into account the needs of the students.	4.29	0.70	3.69	0.55	3.94	0.50
	Item Total	**3.92**	**0.70**	**3.90**	**0.55**	**3.76**	**0.55**
	Item Statement C. The instructional methods of the module are						
1.	Clear and concise.	4.20	0.82	3.92	0.74	3.29	0.58
2.	Easy to understand.	3.79	0.58	4.19	0.58	4.10	0.74
3.	Motivate to develop creative thinking.	4.28	0.84	3.88	0.81	4.22	0.63
4.	Well-defined.	4.34	0.79	4.21	0.40	3.87	0.69
5.	Self-explanatory.	3.53	0.67	4.09	0.77	3.71	0.55
	Item Total	**4.03**	**0.74**	**4.06**	**0.66**	**3.84**	**0.64**
	Item Statement D. The instructional materials/facilities will**:**						
1.	Motivate the students	3.99	0.75	3.67	0.37	2.98	0.51
2.	Facilitate student's mastery of the topics	4.17	0.66	4.16	0.64	4.20	0.83
3.	Help teachers avoid extra teaching which ultimately saves time	3.93	0.74	3.55	0.88	3.63	0.37
4.	Help teachers design their teaching material more effectively	4.25	0.69	4.11	0.69	3.27	0.48
5.	Help teachers select appropriate strategies for teaching.	4.48	0.73	4.25	0.47	3.43	0.40
	Item Total	**4.16**	**0.71**	**3.95**	**0.61**	**3.50**	**0.52**
	Item Statement E. The evaluation techniques will:						
1.	Make students study on their own and attend classes well prepared.	3.24	0.73	4.14	0.48	4.04	0.68
2.	Help in measuring the effectiveness of the topic.	3.79	0.70	4.23	0.86	4.17	0.61
3.	Enable appropriate allocation of marks while setting question papers.	4.33	0.68	4.02	0.38	3.32	0.43
4.	Make midway corrections possible.	3.86	0.72	3.38	0.44	3.94	0.49
5.	Make assessments mapping clear and easy.	4.45	0.64	3.69	0.51	4.01	0.39
	Item Total	**3.93**	**0.69**	**3.89**	**0.53**	**3.90**	**0.52**
	Grand Mean and Standard Deviation	**4.04**	**0.71**	**3.94**	**0.60**	**3.81**	**0.56**

Note: Strongly Agreed (SA=4.50-5.00), Agreed (A=3.50-4.49)

The analyzed data in Table 3 revealed that grand mean and standard deviation of 4.04(0.71), 3.94(0.60) and 3.81(0.56) on validity of the developed instructional module for teaching BIM in EBSU, UNIBEN and UNN. The result indicates that the respondents agreed that the instructional module is valid for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN in South East geopolitical zone, Nigeria.

Research Question 4: To what extent are Technical Education students taught with the instructional module and students taught without the instructional module understand BIM in EBSU, UNIBEN and UNN?

Table 4: *Technical Education students taught with the instructional module and students taught without the instructional module understand BIM in EBSU, UNIBEN and UNN.*

S/N	**Item Statement:** Students understanding of BIM in EBSU, UNIBEN and UNN	Students taught with the instructional module		Students taught without the instructional module	
		X	**SD**	**X**	**SD**
1.	I can navigate the user interfaces of BIM software such as Revit, ArchiCAD, or AutoCAD.	4.26	1.72	3.18	0.48
2.	I acquire the skills to create 3D models using BIM software.	4.18	1.77	3.16	0.46
3.	I can create parametric components and families within BIM software to enable intelligent modeling and design flexibility.	3.93	1.83	2.04	0.43
4.	I can utilize BIM object libraries and content libraries within the software and customize them for specific project needs.	4.39	1.88	3.14	0.51
5.	I can detect clashes and coordination issues in multidisciplinary BIM models and use software tools to resolve these conflicts.	4.17	1.7	2.09	0.31
6.	I can collaborate effectively within BIM workflows, including sharing models, managing version control, and using collaborative platforms like BIM 360.	4.24	1.85	2.24	0.55
7.	I can generate construction documents directly from BIM models, including plans, sections, elevations, and schedules, to communicate project information effectively	3.98	1.94	1.32	0.62
8.	I can use BIM data to perform quantity takeoffs and generate cost estimates, helping in project budgeting and cost control.	4.33	1.91	2.21	0.47
9.	I can produce realistic renderings and visualizations from BIM models to enhance presentations and design reviews.	4.48	1.96	2.27	0.44
10.	I can set up project templates and organize project data efficiently to streamline BIM workflows.	4.42	1.82	2.13	0.39
11.	I can use BIM for sustainable design, energy analysis, and simulation tools to optimize building performance.	3.95	1.76	1.25	0.33
12.	I can utilize BIM for facilities management, including asset tracking and maintenance planning to ensure efficient building operations.	4.4	1.88	2.04	0.26
	Grand Mean and Standard Deviation	**4.23**	**1.84**	**2.26**	**0.44**

Note: Strongly Agreed (SA=4.50-5.00), Agreed (A=3.50-4.49)

The analyzed data in Table 4 revealed grand mean and standard deviation of 4.23, 1.84, 2.26 and 0.44 on students taught with the instructional module and students taught without the instructional module understand BIM in EBSU, UNIBEN and UNN. The result indicates that the students taught with the instructional module agreed that they understand BIM while students taught without the instructional module do not understand the contents of BIM.

DISCUSSION OF FINDINGS

The findings of the study for research question 1 revealed that the contents were considered appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN. The result indicates that the contents are highly appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN in South East geopolitical zone, Nigeria. The finding of this study is in agreement with the finding of Gambari and Yusuf (2014), Aminu (2015) and Hassan (2019), who stated that expert opinions is required for selection of contents considered appropriate for inclusion in instructional module for teaching and learning. The findings of the study for research question 2 revealed that the objectives, methods, materials and evaluation techniques were considered appropriate for inclusion in the instructional module for teaching in EBSU, UNIBEN and UNN. The result indicates that the objectives, methods, materials and evaluation techniques are highly appropriate for inclusion in the instructional module for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN in South East geopolitical zone, Nigeria. The finding of this study is in agreement with the finding of Alshahad (2013), Hassan (2019), Archibong, et al. (2022), who stated that instructional module involves objectives, methods, materials and evaluation techniques that are considered appropriate for the topic to be taught.

The findings of the study for research question 3 revealed that the respondents agreed that the instructional module is valid for teaching BIM to Technical Education students in EBSU, UNIBEN and UNN in South East geopolitical zone, Nigeria. The finding of this study is in line with the finding of Gambari and Yusuf (2014) and Hassan (2019), who noted that the professional assessment of the validity of instructional package and suggestions is required to ascertain the quality of the package for adequate impact on the learners. The findings of the study for research question 4 revealed that the students taught with the instructional module agreed that they understand BIM while students taught without the instructional module do not understand the contents of BIM. The finding of this study is in agreement with the finding of George (2022), Archibong, et al. (2022), who stated that the mean response of trainees who were taught with instructional package (experimental group, 5.89) was greater than the mean score of trainees who are taught with instructional package (control group, 2.79).

Conclusion

Based on the findings of the study, it is concluded that the developed BIM training module is appropriate and fit to be used to train TVET students in tertiary institutions. Incorporating cutting-edge technologies such as Building Information Modeling (BIM) into the educational curriculum serves multiple critical purposes. It not only bridges the gap between theoretical knowledge and practical application but also empowers students to actively contribute to innovation and advancements within their respective fields. Given the growing importance of BIM tools, ensuring that the entire educational process, including the curriculum, students, and learning environment, is Information and Communication Technology (ICT) compliant is essential. The educational system remains in a state of continuous evolution, and the challenges associated with implementing and refining instructional modules are an ongoing aspect of this transformative journey. To effectively integrate BIM into education, it is vital that the university curriculum is strategically designed to close the significant gap between industry requirements and the education provided within the academic setting. Therefore, the curriculum should place a strong emphasis on advanced digital design and construction solutions, ensuring its ongoing relevance and suitability for addressing emerging social and economic demands in Nigerian universities.

Recommendations

From the findings of study, the following recommendations were made:

1. Government authorities across all levels and stakeholders involved in university education should support faculty in obtaining relevant BIM certifications to ensure they are up-to-date with industry standards.

2. Universities should foster relationships between staff and industry professionals to exchange knowledge and best practices by Organizing workshops, seminars, and conferences on BIM to raise awareness and foster a culture of innovation.
3. Universities should provide reliable high-speed internet connectivity to facilitate online collaboration and access to cloud-based BIM tools.
4. Universities should establish and maintain a comprehensive BIM object library to support students' modeling efforts and implement a system for regularly evaluating and improving the BIM curriculum based on feedback from students, faculty, and industry partners.
5. Universities should facilitate internships and industry placements for students to gain BIM practical experience as well as invite industry experts to deliver guest lectures, workshops, and seminars on BIM-related topics.
6. Government authorities across all levels and stakeholders involved in university education should create advisory boards with representation from industry professionals to provide guidance on curriculum development and relevance.

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