



DIGITAL TECHNOLOGIES INTEGRATION IN STEM TEACHING PRACTICES IN TERTIARY INSTITUTIONS IN AKWA IBOM STATE, NIGERIA

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Abstract

Education in the 21st century should be addressed based on availability, accessibility, competency, and usability of digital technologies. Globalization and developments in ICTs, have institutionalized the application of digital technologies in education. This has created a shift in teaching and learning, making the classroom more engaging, compelling, and interesting; giving the teacher new roles, methods, and engagements in and out of the classroom. This study on digital technologies integration in STEM teaching practices in tertiary institutions in Akwa Ibom State, was done using descriptive survey research design. Three research questions and a hypothesis guided the study. The population of the study comprised 1854 STEM lecturers, 270 lecturers were accidentally sampled for the study. A 30-item questionnaire was developed with a reliability coefficient of 0.79 for data collection. Hard and electronic copies of the questionnaire were distributed to respondents. Mean, standard deviation, and independent t-tests were used to analyze the data obtained. Results showed a high level of teachers' competence in integrating digital technologies into STEM teaching practices. Utilization of digital technologies was moderate and male teachers used digital technologies more than the females in STEM teaching practices. Based on the findings, it was recommended among others that tertiary education and teachers' education curricula be restructured to focus on digital abilities, as well as global relevance and exposure. Also, pedagogical practices should be made to embrace the use of digital technologies, so that teachers have adequate knowledge and competencies to meet with increasing needs of society.

Key Words: Digital technologies, Integration, STEM, Teaching Practices, Tertiary Institution.

Introduction

The 21st century illiterate is not one who cannot read nor write, but one who is not ICT compliant, (Ibe Bassey, 2012). Education in the 21st Century is changing, likewise the

pattern of teaching and learning. The outbreak of coronavirus disease (Covid-19), internalization of economies and nations, along with rapid development of ICT are have transformed how we live, work, and



learn (Voogt et al 2013). In Nigeria, apart from Covid-19, struggles with insecurity, religious fundamentalism, hardship and political crises all have implications for education and are evident in its changing nature. Education currently, requires the adoption and integration of modern techniques and practices to achieve teaching and learning objectives.

Science, technology, engineering, and mathematics (STEM) are the foundation of professions and careers, and STEM education emphasizes the acquisition of scientific knowledge and skills through practices and experiences. STEM teaching practices include face-to-face teaching in the classroom, face-to-face teaching with online technology to facilitate a blended teaching and learning environment, digital online teaching and learning as well as practical sessions, feedback, assessments, and other teachers' activities that help students think outside the box. These practices help to promote reasoning, problem-solving, pose purposeful questions, and build procedural fluency from conceptual understanding (Etiubon et al. 2018; Akpan, 2022), making today's classrooms dependent on emerging digital technologies.

Tertiary education is education given after post-basic secondary education. The goals of tertiary institutions include; contribution to national development through high-level manpower training; provide high-quality career and lifelong learning programmes that prepare students with the knowledge and skills for self-reliance and the world of work, as well as reduce skills shortage through the production of skilled manpower relevant to the needs of the society. These goals are achieved through research and development, quality of facilities, services, and resources, as well as a more practical curriculum relevant to the needs of the labour

market and knowledge-based economy (Federal Republic of Nigeria, 2021).

Differences in opinions exist regarding gender involvement with technologies, some opine male students utilize digital tools more than their female counterparts. Ahmed (2015) and Campos et al (2024) opined that a low number of females used electronic resources compared to males, it was observed that male and female teachers may not be equally trained to use ICTs in the classroom. Male teachers are more likely to be trained to teach basic computer skills and computing, because they are more versatile and interested in technology (Itighise, et al., 2023).

Digital Technology and Applications in STEM Teaching Practices

Digital technology is synonymous with digital devices, resources, digital learning/teaching, mobile devices, electronic devices, as well as online and virtual devices. Digital technologies include the use of electronic tools such as the internet, tablets, smartphones, laptops, audio/video streaming, iPads, virtual reality, and other downloadable apps (Facebook, WhatsApp, YouTube, Zoom, AI), as well as devices that generate, store or process data, social media, online games, multimedia, mobile phones, robotics, and drones (Adeoye, 2020; Akpan et al., 2025c). As well as use of digital resources for instructional practices. Digital technologies application in STEM teaching increase students' engagement and creativity, build essential 21st-century skills of collaboration by both teachers and students and help to create self-employment opportunities for people as well as a sustainable business that are offering meaningful work to young people, for survival in a distressed economy. They also increase teachers' efficiency and saves costs, provides immediate feedback and help in individualized learning (Pozo et al., 2021).



Teachers' Integration of Digital Technologies in STEM Teaching Practices

Dewey criticized the academics of his days over a century ago on education's need to adopt new instructional approaches based on future societal needs (Adeoye, 2020). These words have come to pass as the current societal need is information. Teachers and students now share information at any time, any location, and are more inclined to find information often searching, collaborating and issuing instructions via the use of digital tools. While the students easily embrace technology, it is often tough for the teacher to accept same (Akpan et al., 2025c). The 21st century classroom therefore requires a new set of teachers with ICT competence, knowledge, and mindset to support the teaching process. Therefore there is emphasis on highly conscientious and efficient classroom teachers with intellectual and professional abilities adequate to their assignment (FRN, 2021).

The 21st-century classroom depends greatly on emerging digital technologies and the teacher (UNICEF, 2022); this will be achieved when the teachers can identify digital resources, have knowledge and understanding of digital technologies and how these could be used. It also depends on the ability of the teacher to structure their learning environment, manage technology, and develop active classrooms that encourage cooperative, interactive, collaborative learning and group work (Mormah & Bassey, 2021; Akpan, et al. 2025b), while still maintaining a focus on excellent pedagogy (OECD, 2018).

Related Literature

Ojo, et al (2022) posits that using the internet in teaching and learning has improved educational development and research, as well as encouraged virtual interactions, and dissemination of research findings. Tartavulea et al, (2020); Akpan, et al. (2025a)

found a significant positive effect in favour of harnessing technology in learning. Garba and Alademerin (2014), and Chama and Subveerapandiyar (2023) note that most teachers lack the necessary skills and competencies needed for the use of ICTs in their practices.

Olatunde-Aiyedun, et al. (2021) found poor literacy and competence skills among academic staff and students in ICT in public universities in Nigeria. Akpan, et. al (2023) observed that teachers lack knowledge and abilities in being digitally competent to expose students to technologies for learning. Albi-Oparaocha et al (2018) also found that a significant number of teachers are not vast in knowledge and practice, in terms of technological skills. Devera et al (2021) also confirmed that teachers are still struggling with the knowledge, competencies, and strategies required to teach online. On the contrary, Itighise et al. (2023); Akpan (2024) observed that teachers have a high knowledge and practice using different digital devices in science teaching

On the utilization of digital technologies in teaching and learning, Ojo et al (2022); Etiubon et al. (2021); Umoetuk & Akpan (2023) studies show that digital applications and devices are used more by students. Dele-Ajayi (2019) showed that smart/android phones were the most available digital learning devices among university students due to their ease of use and portability, but their use for teaching and learning purposes was moderate. Mugo et al (2017) reported a very low integration and usage of digital devices for teaching by teachers, Tartavulea, et al (2020) maintain that the most common use of digital technologies by teachers was to upload materials and information.

Evidence shows there is a huge gap in the current pedagogical practices for the development of ICT literacy skills and



competence of teachers, this could be attributed to lack of digital literacy and abilities to manipulate the different technological devices among teachers. Teacher training program is mostly theory-driven and leaves teachers unprepared for active teaching and engaged classrooms (Dele-Ajayi et al 2019). Similarly, very little is done in ongoing professional development to support ICT adoption and integration by in-service teachers (Kontagora, et al. (2018). This implies that teachers who received their qualifications years back before the advent of ICTs have little or no training on the use and applicability of digital technologies in the classroom.

On gender, evidence shows that women have a low level of access to and use of ICT as compared to men. Etiubon & Akpan (2017) found that men were more inclined towards the use of ICTs than women. According to Aguboshim, et. al (2022) 46% of boys use the internet, compared to 27% of girls. Male teachers utilized emerging digital technologies in pedagogy than their female counterparts (Akpan et al., 2024). Meanwhile, Umoetuk & Akpan (2023) found that females gained better than males in using digital resources due to interest. Pozo et al. (2021); Akpan and Udo (2025) found no gender differences on utilization of digital technologies.

Statement of the Problem

Closure of schools, harsh economic realities, the changing world of works, emerging online businesses, remote jobs as well as e-examinations, e-payments, e-registrations and many other online services have made the use of digital technologies. more intensive and aggressive. Poor performance by students in most e-examinations, complaints by employers on lack of skills and expertise in the work place and many technologically ignorant people are clear indicators that the traditional teaching and

learning modes are not adequate to cater for today's digital needs. There is a huge disconnect between what is learnt in class, and what the students' actually need to thrive in today's economy and workplace. Therefore, to ensure qualitative education and global competitiveness by our learners, the existing education gap should be bridged by developing digital skills and competencies in learners; and requires the teacher to adopt digital technologies in the classroom. It is in view of above that this study examined digital technologies integration in STEM teaching practices in tertiary institutions in Akwa Ibom State, Nigeria.

Research Questions

1. What is the level of teachers' competence in integrating digital technologies in STEM teaching?
2. What is the extent of teachers 'utilization of digital technologies in STEM teaching practices?
3. What is the difference in the integration of digital technologies in teaching by male and female teachers?

Hypothesis

No significant difference exists in the level of integration of digital technologies by male and female teachers in STEM teaching practices.

Methodology

A descriptive survey design was used for the study to understand opinions on the subject matter. The population of the study comprised 1854 male and female lecturers of science, technology, engineering, and mathematics from state government-owned tertiary institutions in Akwa Ibom State (Akwa Ibom State University, Akwa Ibom State College of Education, Akwa Ibom State Polytechnic, and Akwa Ibom State College of Arts and Science). 270 lecturers were selected for the study using accidental sampling technique.



A 30-item questionnaire on the Integration of Digital Technologies in STEM teaching practices” was used for data collection. The instrument was developed on a four-point Likert scale on teachers’ competence in integration and utilization of digital technologies into teaching practices. The instrument went through a series of validations by experts in Test and Measurement, and Science Education to ascertain its face, content, and construct validation. It was trial tested on 30 respondents who were not used in the study, and a reliability coefficient of 0.79 was obtained using the Cronbach Alpha coefficient. Hard copies of the instrument were distributed physically to respondents, while the soft /electronic copies, a Google form was developed, and the link was sent to the respondents through short messages, telegram and WhatsApp. The responses obtained from both methods of distribution were analyzed using mean, standard deviation, and independent t-test.

Data Analysis

Mean and standard deviation was used for answering the research questions while an independent t-test was used for testing the hypothesis formulated at a .05 level of significance. To make decisions, research questions, with mean values between 1.00-1.49, 1.50-2.49, 2.50-3.49 and 3.50-4.00 for Strongly Disagree, Disagree, Agree, Strongly Agree for competence, as well as Low Extent, Moderate Extent, Great Extent and Very Great Extent for utilization of digital technologies. Where the calculated t-value is greater than the critical t-value, the null hypothesis is rejected and when the calculated t-value is less than the critical t-value, the null hypothesis is retained.

Results

The results obtained are analyzed in line with the research questions and hypothesis that guided the study.

Research Question One

What is the level of teachers’ competence in integrating digital technology into teaching?

Table 1: Mean and standard deviation of the level of teachers’ competence in integrating digital technology in teaching.

S/N	Level of teachers’ competence in integrating digital technology into teaching	Mean	SD	Remarks
1	I can surf online for information	3.60	0.85	Strongly Agreed
2	I hold virtual interaction with my students and colleagues	3.02	0.88	Agreed
3	I have the skills to share course materials digitally.	3.27	0.88	Agreed
4	I explore with Google for materials to aid in class	3.24	1.01	Agreed
5	I get materials and information from AI-ChatGPT to teach.	3.06	0.90	Agreed
6	I have knowledge of digital applications	3.67	0.63	Strongly Agreed
7	I apply knowledge of various packages on my phone in teaching	3.19	0.81	Agreed
8	I have the skills to apply video streaming to teaching	2.68	1.13	Agreed
9	I can project my lessons using the computer	2.55	1.05	Agreed
10	I organize online discussions and lessons with my students.	2.17	1.17	Disagreed
	Cluster Mean	3.05	0.93	Agreed



Results in Table 1, show mean response of the level of teachers' competence in integrating digital technology in teaching. Items 1 and 6 fall within 3.50-4.00, meaning the respondents strongly agree that they have the knowledge of surfing online for information and knowledge of digital applications. Responses on 2,3,4,5, 7,8, and 9 falls between 2.50-and 3.49 meaning respondents agreed that they have virtual interaction with their students and colleagues, have the skill to share course materials digitally, explore with Google for materials and get information from AI-ChatGPT to aid in teaching, apply knowledge of various application packages on their mobile phones and have the skills to apply video streaming in teaching as well as project

their lessons using the computer. The result further shows that the response on item 10 falls within 1.50-2.49 meaning majority disagreed that they can organize online discussions, lessons, and teachings with their students. The standard deviation scores of the respondents range from 0.63 to 1.17, are not far away from each other, meaning the respondents share similar views on the items. A cluster mean of 3.05 for all the items implies a high level of teachers' competence in integrating digital technology into teaching.

Research Question Two

What is the extent of teachers' utilization of digital technologies in STEM teaching practices?

Table 2: Mean and standard deviation of the extent of teachers' utilization of digital Technologies in STEM teaching practices

S/N	Extent of integration of digital technology in teaching	Mean	SD	Remarks
11	I use computer software to teach in class	2.16	0.94	Moderate Extent
12	I use digital audio player to teach my course	1.82	0.92	Moderate Extent
13	I use a digital camera to aid teaching activities.	1.81	0.95	Moderate Extent
14	I use digital television in teaching activities	1.59	0.90	Moderate Extent
15	I use digital video streaming in my teaching	1.67	0.84	Moderate Extent
16	I show my students how to use online publications	2.79	1.03	Great Extent
17	I use AI-ChatGpt to get information	2.72	0.92	Great Extent
18	I log on to Google to explore and confirm information	3.38	0.83	Great Extent
19	I interact with my students virtually for discussion	2.52	1.07	Great Extent
20	I interact with my colleagues virtually for meetings	2.72	0.94	Great Extent
21	I use my personal mobile phones for teaching	2.58	1.00	Great Extent
22	I use PowerPoint app. for teaching	2.37	0.99	Great Extent
23	I take my students on virtual field trip	1.93	0.93	Moderate Extent
24	I use of WhatsApp to share information with students	2.76	0.99	Great Extent
25	I schedule lessons, meetings with students via Zoom	1.56	0.82	Moderate Extent
26	I use Facebook to connect with my students	2.29	1.07	Moderate Extent
27	I make use of a projector during teaching	2.31	1.05	Moderate Extent
28	I use computer simulations while teaching	2.32	0.95	Moderate Extent
29	I use YouTube to show students activities they can carry	2.17	1.05	Moderate Extent



30	I encourage students to play online games and activities	2.61	0.99	Great Extent
	Cluster Mean	2.31	0.96	Moderate Extent

Results in Table 2 indicate mean range of responses on the extent of teachers' utilization of digital technologies in STEM teaching for items 11, 12, 13, 14, 15, 23, 25, 26, 27, 28 and 29 fall within 1.50-2.49 which means a moderate extent of respondents use computer software in class, use digital audio player to teach their course, use a digital camera to aid teaching activities, use digital television in teaching activities, use digital video streaming in teaching, go on virtual field trip with students, schedule lessons, meetings via zoom, use Facebook to connect with their students, use projector during teaching, use computer simulations, and use YouTube to show students hands-on-activities to do. The result also showed that the responses on 16, 17, 18, 19, 20, 21, 22, 24 and 30 fall within 2.50-3.49 which means to a great extent they use Online publication, AI-ChatGPT to get information, google to

explore and confirm information, interact with their students and colleagues virtually for discussion, meetings and training, use mobile phones, use PowerPoint app. for teaching, use of WhatsApp with students to share information, and encourage students to play online educational games and activities. From observation, the standard deviation scores of the respondents range from 0.82 to 1.10, the scores are not far from each other which means the respondents share similar views on the items. Also, the cluster mean of 2.31 for all the items implies teachers utilize digital technologies in teaching to a moderate extent.

Research Question Three

What is the difference in the integration of digital technology in STEM teaching by male and female teachers?

Table 3: Mean and Standard Deviation of the difference in the integration of digital technology in STEM teaching practice by male and female teachers (N=270)

Gender	N	$\bar{x}$	SD
Male	159	53.52	14.39
Female	111	46.83	14.11

Results in Table 3 show a mean score of 53.52 and a standard deviation of 14.39 for male teachers while that of their female counterparts is 46.83 and the standard deviation is 10.11. This implies a difference in the integration of digital technology in STEM teaching practices by male and female teachers, with male teachers integrating

digital technology more in teaching than female teachers.

Hypothesis1

There is no significant difference in the integration of digital technology in teaching by male and female teachers.

**Table 4: Independent t-test analysis of the difference in the integration of digital technology in STEM teaching by male and female teachers (N=270)**

Gender	n	$\bar{x}$	SD	t-cal	t-crit	Decision
Male	159	53.52	14.39	4.22	1.97	Significant
Female	111	46.83	14.11			

The result in Table 4 shows the calculated t-value of 4.22 is greater than the critical t-value of 1.97 at 268 degrees of freedom and .05 level of significance. This implies that there is a significant difference in the integration of digital technology in STEM teaching practices by male and female teachers.

Discussion of Findings

Analysis of teachers' competence in integrating digital technologies in STEM teaching practices indicated a high level of teachers' competence in integration. This finding agrees with Itghise, et al. (2023); Akpan (2024); Akpan et al., (2025c) that there is a paradigm shift in using digital resources for instructional practices and teachers now practice using digital technology. Thus, it is deduced that most teachers are competent in the use of these resources. The findings contradict that of Garba & Alademmerin (2014); Olatunde-Aiyedun, et al. (2021); Devera et al (2021); Chama and Subveerapandiyani (2023) that teachers' integration of technology is low due to a lack of knowledge and competence as most are not technologically literate. The high level of competence in integrating digital technology in teaching could be because tertiary institution lecturers use digital resources more often in teaching, research, and as a means of communication.

Analysis of the extent of teachers' utilization of digital technology in STEM practices indicated that teachers integrate digital technology in teaching to a moderate extent. Finding agrees with Tartavulea, et al, (2020)

and corroborates Ojo, et al (2022) that the successful adoption and usage of digital devices and ICT in education is fundamental to both content and pedagogy that is at the heart of education in the 21st century.

Analysis of the difference in the integration of digital technology in teaching by male and female teachers indicated that there is a significant difference in the integration of digital technology in favour of male teachers. This finding lends credence to Ahmed (2015) that male and female teachers are not likely to be trained equally to use ICTs in the classroom. It also agrees with Etiubon & Akpan (2018); Aguboshim, et al. (2022), Akpan, (2024); Akpan et al. (2024) that female students are less likely to use ICTs when compared to their male counterparts. This outcome is attributed to the stereotype about technology being for boys and the lack of interest in technological subjects by females.

Conclusion

It takes problems or unpleasant incidences like Covid-19 lockdown, globalization and the changing world of works and to unleash one's potential and discover new, better, and more convenient ways of doing things. Based on the findings of the study, it was concluded that tertiary institution teachers possess a high level of competence in integrating digital technology, but moderately utilize them in STEM teaching practices. It was concluded that male teachers integrate digital technologies more often than their female counterparts.



Recommendations

Following the findings and conclusions of the study, recommendations were made that:

1. Professional development programmes for lecturers (workshops, conferences,) should be encouraged and financially supported.
2. Teachers and students should be encouraged to work remotely, using digital resources.
3. Government should fund tertiary institutions sufficiently, and non-governmental organizations and stakeholders should partner to provide interventions in emergent digital resources in the classrooms for students' use practically
4. The curriculum of tertiary institutions should be restructured to include digital literacy, digital entrepreneur and digital skills to produce graduates who can survive in the new world order.
5. The teacher education curriculum should be restructured such that pedagogical practices embrace the use of digital technologies and provide opportunities for teachers to have appropriate knowledge and skills to meet the needs of their students and the globalized world.

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