EMERGING TECHNOLOGIES FOR TEACHING AND LEARNING OF BASIC SCIENCE EDUCATION PROGRAMME IN THE NEW NORMAL IN TERTIARY INSTITUTIONS IN NIGERIA

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Abstract
Technologies are ubiquitous in the 21st century, and educators need to integrate relevant technologies into their teaching practices to meet expectations and keep abreast with the education profession's advancement. A descriptive survey research design was used in this study. Three research questions and one null hypothesis guided the study. The population of the study comprised all the 24 Integrated Science lecturers (10 males and 14 females) in both private and public tertiary institutions in Enugu State, Nigeria. The population was manageable and as a result no sample was carried out for the study. An instrument titled "Questionnaire on Emerging Technologies in Teaching and Learning" (QETTL). Three experts validated the instrument while the reliability of the instrument was estimated using Cronbach Alpha formula with reliability indices of 0.76. Frequency, percentage, mean and standard deviation were used to answer the research questions while Chi square statistics was used to test the null hypothesis. Findings revealed that some of the challenges hindering Basic Science teachers from utilizing technologies in teaching and learning are lack of internet access and in-service training among others. Based on the findings, it was recommended among others that in-service training of lecturers on the usage of 21st century technologies and provision of internet connectivity should be prioritize by government and the university management to enable lecturers maximize effectively 21st century technologies during teaching and learning.

Keywords: Basic Science, Emerging Technologies, Gender, Learning, New Normal, Teaching.

Introduction
Technology is a transformative tool in teaching and learning. With the teacher's pedagogical practices, it becomes an important tool to ignite interests and enhance the motivational aspects on the learners. In fact, many technological applications are designed to make changes in the delivery of instruction especially in the new normal. Technology plays an immense role in humans' lives, revolutionising many fundamental activities and penetrating most areas, including education (Raja & Nagasubramani, 2018),

transforming research activities, scholarship and services to society in the academic field and enhancing teaching and learning (Rana, 2017). Educational technology refers to technology integration into the curriculum, altering the educational process (Cloete, 2017). Students develop new skills and enhance their learning experience through various technology platforms (Lawrence & Tar, 2018).

Technology supplements teaching materials, offering students a new customisable learning experience with a self-paced, problem based, interactive learning environment, improving their knowledge and understanding (Moro et al., 2021). Educational technology improves students' motivation, satisfaction, attitudes, interaction, engagement and academic performance (Akçayır & Akçayır, 2016; Moro et al., 2021; Saltan & Arslan, 2016). The massive changes brought by technological advancement in the scientific field necessitate Basic Science lecturers to embrace technology for effective communication, better teaching aids and to assist students' self-expression (Mohd Yusof & Tahir, 2017). Educational and professional courses acknowledge technology's importance in contemporary teaching (Watty et al., 2016). Basic Science education needs to progress, develop, adopt and advocate for good governance in technology application to accommodate the new trend in the human capital market (Yap et al., 2014). The World Economic Forum (2018) reported several declining occupations due to technology's advancement; any subject curriculum neglecting technology aggravates the situation (Burritt & Christ, 2016). Nevertheless, Basic Science Lecturers welcome the advancement of technology. Taib et al. (2022) noted the high correlation between digitalization with lecturers' technology readiness, yet technological knowledge and usage do not depict the current industrial needs. The shifts in the role of teaching from merely use of traditional methods to innovative and information technology knowledge leads to better decision-making.

Technology integration into Basic Science education is vital because rapid technological growth affects the global economy and changes teachers' roles (Ogundana et al., 2015). Accordingly, the educational setting must efficiently and effectively provide content adapting to these changes (Birt et al., 2018). Moreover, future graduates are entering a technology-rich workplace requiring sufficient digital technology literacy skills to operate efficiently (Ahmad & Mohd Rhouse, 2016). Basic Science lecturers are responsible for shaping future science professionals to bridge the gap between the current issues. The Basic Science curriculum and scientific practice asserted that technology integration into Basic Science education allows students to gain relevant knowledge, skills and abilities.

Lecturers' responsibilities include transferring knowledge and providing guidance and training to students. lecturers are key stakeholders in integrating technology into the education system (Qasim & Kharbat, 2020). The role is poorly executed, causing a disparity between industry demands and graduates' quality. Higher institutions lag in adopting innovative pedagogy and overlook complex skills fostered by technology (Moro et al., 2021). One key reason is lecturers' reluctance to embrace the information

age. Studies reveal the unoptimised and minimal integration of lecturers' technology usage (Taib et al., 2022; Lawrence & Tar, 2018; Watty et al., 2016) because lecturers opined the challenges – time constraints, accessibility, and network connection, lack of training and competency, and little technical support – outweigh the benefits (Milutinovic, 2022; Awang et al., 2018). Lecturers are also concerned about losing control over how their students manage tasks with technology integration (Gurjar & Sivo, 2022; Moro et al., 2017). Hence, debate between educational institutions and industry players over educational technology adoption is ongoing due to the gap between employers' expectations and requirements relating to technology competency and the actual skills and abilities of Basic Science graduates. This study describes the 21st century educational technology usage among Basic Science lecturers in their practices through an overview of educational technology usage frequency, tools and platforms used.

Integrating e-learning and other educational technologies affected Basic Science education. Technology application in Basic Science education enables interactive, constructive and independent learning (Delgado et al., 2015), improving classroom activities' effectiveness and student engagement (Dua et al., 2016; Mirzajani et al., 2016). Technologies applicable in Basic Science education are web applications and relevant technology devices used to prepare teaching materials, tests and tutorials and engage with students (Kearney et al., 2017; Khatib, 2016). New experiential learning allows students to better understand, decode and learn the material (Moro et al., 2017). Incorporating technologies into Basic Science education encourage progress and good governance in technology usage and adoption (Asonitou, 2020) for the 21st century educational setting. Technology integration in Basic Science education considers the intersection of content, pedagogical and technological knowledge for effective instruction to achieve learning goals.

Technology integration is introducing modern facilities and various technologies into teaching and learning of different courses. Technology integration eases knowledge transference and encourages creativity, collaborative problem-solving and independent learning. Scholars believe emerging technology improves students' performance, stimulates creativity and innovative thinking, and promotes student engagement (Qasim & Kharbat, 2020; Mohd Yusof & Tahir, 2017; Cheah, 2016). Also, technology integration nurtures students' cognitive processes (Moro et al., 2017). Emerging technology in teaching and learning have identified various instructional technologies (hardware or software) for lecturers' usage (Abu Karsh, 2018).

Technology does not replace pedagogy but rather enhances teaching and learning (Al-Emran & Shaalan, 2015). Watty et al. (2016) suggested using Web 2.0, Web 3.0, cloud computing, tablets and smartphones, games and gamification, learning management systems and massive open online courses (MOOCs). Augmented reality (AR), virtual reality, 3D printing and mobile devices could be key educational technology for learning engagement (Birt et al., 2018; Johnson et al., 2016), facilitating

information delivery, collaboration, connection and communication between students, peers and lecturers. Some of the educational technologies for the 21st century classroom with specific examples are tabulated in appendix 1. Technology is evolving; nevertheless, current technology is viable for creating a technology-enhanced learning environment (Moro et al., 2021). Lecturers must holistically prepare students and produce work ready graduates for job market demands (Darling-Aduana & Heinrich, 2018). Researchers have emphasised technological tools and applications provide opportunities and improve education quality and student engagement (Gurjar & Sivo, 2022; Taib et al., 2022; Ilias et al., 2020; Qasim & Kharbat, 2020; Wu et al., 2019; Al-Htaybat et al., 2018; Mavroudi & Tsagari, 2018). The above discussion highlights a symbiotic relationship between 21st century technology and teaching and learning especially in Basic Science education. Technology adoption and integration are inevitably essential, and the role of lecturers are crucial irrespective of gender.

Gender is the role assigned to males and females by the society. Gender is a personality trait, attitude, behavioural values, relative power, influence, roles and expectations that the society ascribes to the two sexes (Eze, 2013). gender is inculcated through norms, morals, training, orientation and indoctrination in the society. The difference in training, orientation and indoctrination and likes result to differences in the way male and female students learn. According to Cornell (2003), female students are statically learning inclined that is expected as static. Concrete and visual instructional materials are enjoyed by by and effective with boys; such as moveable clocks, protractors, thermometer that ensure some hands-on-activity (Cornell, 2003; Obodo & Ani, 2022). based on the assertions the researchers want to find out whether or not Basic Science lecturers usage of 21st century technologies is dependent on gender. Both male and female Basic Science lecturers may face some challenges in the usage of the 21st century technologies. Hence the study also investigated such challenges.

The challenges face by Basic Science lecturers in the usage of 21st century educational technologies are of interest to the researchers. These challenges if found and addressed could promote the usage of 21st century educational technologies in the new normal among the Basic Science lecturers. Basic Science lecturers teach students who will in turn teach sciences at primary and secondary school levels. So if this set of teachers are use 21st century technologies to teach sciences, it will not only make the teaching and learning of sciences interesting, curiosity provoking and meaningful but also inculcate the skills of the use of 21st century educational technologies to the would be teachers, hence, the need for this study. This study therefore, sought to determine the 21st century technologies used by Basic Science lecturers in teaching and learning of Basic Science education programme in the new normal in tertiary institutions in Enugu State, Nigeria. Specifically, the study determined the:

i. The 21st century technologies used among Basic Science lecturers in both private and public tertiary institutions in Enugu State, Nigeria.

ii. Challenges encountered by Basic Science lecturers in the utilization of 21st century educational technologies in teaching and learning in the new normal.
iii. Influence of gender on 21st century educational technologies usage among Basic Science lecturers in both private and public tertiary institutions in Enugu State, Nigeria.

Research Questions

The following three research questions guided this study:

1. How frequently do Basic Science lecturers use the 21st century educational technologies in teaching and learning process?
2. What are the challenges encountered by Basic Science lecturers in the use of 21st century educational technologies?
3. What is the influence of gender on 21st century technologies usage among Basic Science lecturers in tertiary institutions in Enugu State, Nigeria?

Method

Descriptive survey research design was employed in this study. Three research questions and one null hypothesis guided the study. The population of the study comprised all the 24 Integrated Science lecturers (10 males and 14 females) in both private and public tertiary institutions in Enugu State, Nigeria. The population was manageable and as a result no sample was carried out for the study. The selected Basic Science lecturers possessed the highest integrated Science qualification and experience in teaching and learning of Basic Science subjects regardless of position grade, terms of appointment, specific university establishment and location; lecturers teaching non-science subjects were excluded to avoid deviation from the Basic Sciences' perceptions and definitions. All the 24 Basic Science lecturers were selected and used for the study. Science lecturers with experience using any of the 21st century educational technologies were eligible to participate; lecturers without the relevant experience were excluded. An instrument titled "Questionnaire on Emerging Technologies in Teaching and Learning" (QETTL). The questionnaire used for the study consisted of two sections. Section A recorded demographic information, and Section B was sub-divided into two clusters, namely Cluster I and II. Cluster I was structured on two point scale of "Used" (U=2) and "Not Used" (NU=1). Cluster II deals with the challenges faced by Basic Science lecturers in the use of 21st century educational technologies. Cluster II was structured on four-point Likert type scale of: Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD). The instrument was face validated using two experts in Educational Technology and one expert in Measurement and Evaluation, all in Enugu State University of Science and Technology, Enugu. The reliability of the instrument was done in two parts. For Cluster I which is dichotomously scored, Kudder-Richardson, 20(KR-20) was used, while Cluster II which is non-dichomously scored, Cronbach's alpha was used. The reliability estimates of 0.82 and 0.76 were

arrived at for Clusters I and II respectively. The researchers and two research assistants distributed the instrument to the Basic Science lectures and their responses were collected on the spot and used for the study. Appendix 2 contains the respondents' demographics. Frequency and percentage were used to answer research question one while mean and standard deviation were used to answer research question two. Chi square statistics was used to test the null hypothesis.

Results

Table 1 presents the results of the demographic analysis. The majority were female, with 30 respondents (66.6%) and 15 male respondents (33.3%). Most respondents were between 41 and 50 years old (35.6%), followed by 31 and 40 years old (20.0%), followed by 51 and 60 years old (15.5%), 11.1% aged 24 and 30 years old & 61 and 70 years old respectively and 16.4% aged 50 years and above. About 55.6% of the respondents have a doctorate, 33.3% have a master's degree, 11.1% have bachelor's degree and 0% have a professional qualification. Almost quarter (24.4%) were senior lecturers, followed by lecturers I (17.7%), lecturers II (15.5%), professors (13.3%), associate professors (11.1%). Assistant lecturers and graduate assistant lecturers have a similar percentage (8.9%). Approximately 48.8% of respondents have served for less than 20 years, 26.6% for less than 25 years, and 11.1% for 26 to 30 years, 13.3% of respondents have more than 30 years of working experience.

Table1: Demographic profile of the respondents (N = 24)

S/N	Demographic Profile		Frequency	Percentage
1	**Gender**	**Male** **Female**	**10** **14**	**33.3%** **66.6%**
2	Age	24–30 years Old 31–40 years Old 41–50 years Old 51–60 years Old 61–70 years 0ld Above 70 years	03 05 07 04 03 **02**	**11.1%** **20.0%** **35.6%** **15.5%** **11.1%** **6.7%**
3	Highest education level	Doctorate (PhD) Master's degree Bachelors degree Professional qualification (e.g.,NCE, TCII)	**16** **05** **03** **0**	**55.6%** **33.3%** **11.1%** **0%**
4	Current academic appointment	Professor Associate Professor Senior lecturer Lecturer I Lecturer II Assistant Lecturer Graduate Assistant Lecturer	**04** **03** **04** **04** **05** **02** **02**	**13.3%** **11.1%** **24.4%** 17.7% **15.5%** **8.9%** **8.9%**
5	Working	5 years and below	04	**8.9%**

	experience as a lecturer (years)	6–10 years 11–15 years 16–20 years 21–25 years 26–30 years Above 30 years	06 10 02 12 **05** **06**	**13.3%** **22.2%** **4.4%** **26.6%** **11.1%** **13.3%**
	Teaching hours spent per week	3 hours and below 4–9 hours 10–15 hours 16–20 hours Above 20 hours	07 12 10 09 07	15.5% 26.6% 22.2% 20.0% 15.5%

Most of the respondents (26.6%) spent about 4 to 9 hours a week on teaching activities, and 20.0% spent around 10 to 15 hours a week on teaching activities while 20.0% of respondents spent 16 to 20 hours and 15.5% of respondents spent 3 hours below and 20 hour above respectively.

Table 2: Respondents' Educational Technology Usage Profiles (N = 45)

S/N	**Cluster Statement**		**Frequency**	**%**
1	Usage frequency in teaching and learning	Rarely used Occasionally used Frequently used Use almost always Use all the time		**s**
2	Educational technology tools	Smartphone Tablet Laptop Desktop computer LCD projector Interactive whiteboard Smart television Camera video device Sound device Software and applications Others	07 10 12 09 08 10	
3	Educational technology platforms	Learning management system (LMS) Social media or collaborative technologies Communication Simulated learning systems Learning styles or approach concepts Mobile technologies Assessment or evaluation technologies Presentation and learning resource creation tools Learning objects or resources Common accounting tools		

Table 2 summarizes the respondents' educational technology usage of the 21st century technologies listed in Table 2. About 34.9% of respondents admitted using educational technology in their teaching activities all the time; 3.1% rarely use it. Laptops, desktop computers and LCD projectors were the most used technological devices. Tablets, camera video devices, sound devices, software and applications were seldom used. Smart televisions and interactive whiteboards were least used. As for the technological platforms, most respondents (70.3%) used LMSs, followed by communication platforms (68.2%) and mobile technologies (50.8%). Only 7.7% of respondents simulated the learning system for their classroom strategies. Other technology platforms (learning styles or approach concepts; mobile technologies; assessment or evaluation technologies; presentation and learning resource creation tools; learning objects or resources; common accounting tools) show less and average usage.

Discussion of the Findings

This study investigated 21st century technology usage in Basic Science educators' practices. The findings describe their pattern of educational technology usage frequency, tools and platforms used. The following subsections describe this pattern's theme and elaborate on the quantitative analysis result.

Usage frequency of 21st century educational technology

Table 5 describes accounting educators' usage frequency of 21st century educational technologies in Table 3 (either rarely, occasionally, frequently, almost always, all the time) in the classroom. About 34.9% of respondents fully integrated technologies into their practices; 26.2% used them frequently. Meanwhile, 25.6% used them almost always, 10.3% occasionally and 3.1% rarely. Educators must embrace educational technology because technology significantly impacts people's lives and activities (Abu Karsh, 2018; Ahmad & Mohd-Rhouse, 2016). With more comprehensive technological advancements available, the usage frequency should be higher (Allison, 2022). Efforts were noted but they were insufficient for instilling the maximum learning experience for students' skills development.

Educational technology tools used

The findings suggest that accounting educators mostly use desktop computers (77.4%), LCD projectors (78.5%) and laptops (79.5%), similar to the findings of Ahadiat (2008) and Goksun et al. (2018). The findings of our study conducted in 2020 projected a similar pattern to previous studies. The technology tools' high usage could be due to familiarity, as some have been used since the 1990s and are Kunjappan et al., 2016). However, our findings reveal widespread usage of smartphones in teaching and learning (65.6%). Several scholars (Lawrence & Tar, 2018; Taib et al., 2022) mentioned that while many educators embraced technology in their practice, they disregarded other 21st century educational technologies; for instance, interactive whiteboards and smart

televisions might be mostly unavailable in education institutions due to their high cost and training requirement. The unavailability of facilities and infrastructure was potentially the main challenge and barrier to teaching using technology (Abdullah et al., 2016; Ghavifekr, Abd Razak et al., 2014). Hindering factors such as the lack of classroom facilities, cost, technological competency and unfamiliarity with current technology deter educators from changing and disrupt the integration that could enhance educators' effectiveness and interactive pedagogy (Alshmrany & Wilkinson, 2017; Dua et al., 2016).

Educational technology platforms used

The findings show that the most used platforms by accounting educators were LMSs (70.3%), communication (68.2%) and social media or collaborative technologies (52.3%). Blankley et al. (2018) corroborated that accounting educators naturally use LMSs. The faculty or institution usually provided the platform, hence, the familiarity or obligation to use it. Although LMSs support the teaching process, their functions are limited to paperless work (Blankley et al., 2018), which is insufficient for instilling technological skills among students as demanded by IR4.0. Likewise, the findings indicate educators' minimal usage of the flipped classroom learning approach, gamification (e.g., Padlet, Kahoot, Socrative, Nearpod) and blended learning; they create game-based activities and animations to help students learn (Watty et al., 2016). Several researchers highlighted critical infrastructure, facilities and support for educators to embrace educational technology (Abu Karsh, 2018; Alshmrany & Wilkinson, 2017; Gordon et al., 2018). Other factors were educators' attitudes, knowledge, skills and technology capabilities (Scherer et al., 2019; Weng et al., 2018). Educational institutions and the government's strategic approach, training and support could result in the integration of 21st century educational technology platforms into education.

Conclusion

Technology nowadays is inevitable. Its application is ubiquitous across sectors, including education, and continuously evolving; thus, accounting educators must proactively embrace 21st century technology in their practices. The numerous tools and technology platforms and industry demands necessitate educators to embrace technologies to equip graduates with technological skills and knowledge. Consequently, educational institutions must create a technology-integrated environment that motivates educators to use interactive 21st century educational technology in their classrooms. They must adopt various contemporary educational technologies to facilitate interactive teaching pedagogy and enhance students' learning experiences. Furthermore, the findings reveal technology characteristics, organisational factors and individual factors significantly influence Basic Science educators' usage behaviour towards 21st century educational technology. The findings provide invaluable insight into Basic Science educators' uses of technology in their practices. Educators are crucial in demonstrating the effectiveness of

technology integration in preparing future graduates that embrace the profession's volatility, uncertainty, complexity, and ambiguity. Therefore, teachers and school management responsible for the Basic Science curriculum should consider initiatives to exploit and maximise 21st century educational technology use in instructional design.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Future research should be explore the impact of COVID-19, at least after 3 years, to examine the probable changes in technology adoption. Further, researchers could also increase the sample size for both quantitative and qualitative measures to draw solid and rigorous conclusions.
2. The findings reflect 21st century educational technology usage; therefore, another possibility is for future research to explore the influence of individual factors on this phenomenon.
3. Future studies could utilise the proposed model for empirical testing to validate the model and discover more concrete findings.

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Appendix 1: 21st Century Educational Technologies Used in Teaching and Learning

S/N	21st century Educational technologies	Example
1	Learning management systems (LMSs)	Moodle; Blackboard; Desire2Learn; iLearn System; MOOCs; iFolio; Claroline; MyGuru2; Learning Care; Learning Cube; Blackboard; MyLMS
2	Learning styles or approach concept	Flipped Classroom; Gamification; Padlet; Nearpod; Kahoot! Socrative; blended learning; mobile learning; distance or online learning, Peardeck
3	Social media or collaborative technologies	Blogs; Wikis; Twitter; Facebook; Instagram; YouTube; Google Drive; Dropbox; Vimeo; Metacafe
4	Communication	Asynchronous (e.g., online discussion board; email; WhatsApp; WeChat; Telegram) Synchronous (e.g., Skype; Google Chat; Adobe Connect; Bloomz; Remind; Sli.do)
5	Simulated learning systems	The Normalised Game; Legends of Learning; Classcraft; SiLAS Solutions; CodaQuest; Animoto, Legends of Learning
6	Mobile technology	Tablet computer; smartphones; mobile apps (e.g., iOS, Android)
7	Technology assessment or evaluation	Quizlet; Quizlet live; Google Classroom; Quizizz; Formative; MOOCs; ZipGrade; Flipgrid; Scan Attendance Manager; Plickers; Kahoot!; Write to Pdf; Google Spreadsheet; Google Form; ClassDojo
8	Presentation and learning resource creation tools	*Software* (e.g., Adobe Presenter; voice recognition software; Microsoft PowerPoint; Google Slide; Book creator; Adobe Captivate; screen capture, i.e., Jing, Camtasia; Prezi; Powtoon; Padlet; Nearpod; Google Slides; Canva; PiktoChart; Adobe Acrobat Reader; Showbie; Plotagon Education) *Hardware* (e.g., drawing tablet, i.e., Wacom; microphones; In class Document Reader; smartphones
8	Learning objects or resources	eBooks; lecture notes or slides; narrated PowerPoint slides; podcast, i.e., audio & video; video lectures; instructional videos; automated video drawings; Flickr; Google Photos; Photobucket; Google Drives; QR code scanner