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ORIGINAL RESEARCH

ICT integration into the teaching and learning of science: experiences and perceptions of secondary school teachers

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Abstract

The integration of Information and Communication Technologies (ICTs) in education became crucial after the COVID-19 epidemic. Few studies have examined how ICTs are utilised to teach science in developing nations like Nigeria. This qualitative case study investigated secondary school teachers' perspectives and experiences with integrating ICTs in science teaching in Nigerian classrooms using semi-structured interviews with six science teachers from an education district in Lagos, Nigeria. Content analysis of the information gathered indicates that sampled teachers demonstrated positive perceptions of performance and effort expectations toward using ICTs in science teaching and learning but rarely used these technologies in their classrooms. The findings attributed sampled science teachers' low use of technologies to their perceived lack of facilitating conditions, including limited technological resources and access to digital devices, unreliable electricity supply, poor technological pedagogical content knowledge, and lack of support and funding. Thus, teachers should be provided with basic support, access to functioning technical tools like computer laboratories, and effective technology training for scientific teaching and learning.

Keywords: Information and communication technologies; teachers' perceptions; secondary schools; science education; unified theory of acceptance and use of technology

Introduction

The need to promote science, technology, engineering, and mathematics (STEM) education cannot be over-emphasised in the ever-changing educational landscape. These disciplines function as the foundation of innovation, propelling advancement in our technologically sophisticated society. According to the World Economic Forum report (Heuer, 2015), science, technology, engineering, and mathematics are crucial to the future quality of human life and are among the most critical development goals defining the world's development and sustainability. As a result, integrating information and communication technologies (ICTs) in education has become very significant in transforming science teaching and learning within formal and informal educational contexts (Alemu, 2015). Studies show that integrating technology into science education enables teachers to illustrate complex procedures in real-time, provoke deeper thought processes, increase student engagement and promote student retention (Correia et al., 2019; Office of Elementary and Secondary Education, 2020). According to Ekici and Pekmezci (2015), the utilisation of visual, auditory, and tactile experiences enhances the effectiveness and long-term viability of science teaching and learning. In light of this, an example of incorporating technology in the science classroom can include the presentation of videos and movie clips about scientific ideas and discoveries or giving students simulation activities on concepts taught (Correia et al., 2019). The National Science Education Standards of the United States encouraged teachers to use a range of information communication technology tools as integral components of science instruction to promote student inquiry and 21st-century skills (National Research Council [NRC], 1996). Utilising ICTs in science classrooms also enables students to work

as scientists (NRC, 1996). According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), the use of ICT has the potential to transform pedagogical methods, increase access to quality education, lead to a better and more engaging learning experience, improve the management of education, and change the interaction between schools and students (UNESCO, 2011). In this regard, UNESCO has launched a number of projects and initiatives aimed at improving education in African countries through the use of ICTs (UNESCO, 2015, 2020). However, research indicates that many teachers are not comfortable using technology in their science classrooms (Hyndman, 2018) despite the various initiatives and significant developments in educational technologies that have been made. Studies have shown that the use of technology in supporting the teaching and learning of science continues to face a number of challenges, particularly in the Global South (developing countries) (Jita & Munje, 2020; Obaydullah & Rahim, 2019; Paje et al., 2021). Some of these challenges include limited financial resources, underprepared educators, inadequate educational facilities, cultural differences, insufficient teaching materials, exclusion of children with impairments and lack of supporting policies (Jita & Munje, 2020; Lim et al., 2020). However, the rapid development in technological advancement has influenced recent education reforms in several countries, now emphasising the integration of technology into science instruction to prepare students better for the science and technology of the 21st century (Kwok, 2018).

Nigeria has implemented numerous policy and educational reforms over the last two decades to improve its education system. However, the country remains technologically disadvantaged as technology integration into science education faces several inequities (Osarenren-Osaghae & Irabor, 2018). In addition, the disruption caused by the COVID-19 pandemic has resulted in numerous new norms and adjustments to the use of technology in educational institutions worldwide, including Nigeria. These changes include a significant increase in the use of ICTs in schools to transform teaching and learning practices within formal and informal educational contexts. For instance, the Lagos State Government in Nigeria introduced educational technologies in classrooms to improve students' ability and learning outcomes (Oolasunkanmi2, 2022). The government also introduced technology-driven modular classrooms made of shipping containers in 2022 (Oolasunkanmi2, 2022). These container classrooms are designed as laboratories for hybrid learning for children in public secondary schools (Oolasunkanmi2, 2022). Despite the availability of several adaptive technologies for teaching and learning, incorporating technology into science instruction remains a daunted task for the majority of science teachers in the state, particularly in public schools. Teachers' contributions to integrating ICT in instruction are crucial in achieving policies and reforms; nonetheless, teachers' views and experiences towards technology use are arguably predictors of the successful integration of ICT in science teaching (Arkorful et al., 2021). Thus, this research examined teachers' views of their experiences in integrating ICTs to support the teaching and learning of science in Nigerian classrooms. The research question addressed was: What are secondary school science teachers' perceptions regarding using ICTs to support science teaching and learning in Nigerian classrooms?

Literature review

Technology in science classrooms

Technology has become increasingly common in our everyday lives, leading to changes in teaching and learning. As a result, its integration in science classrooms has become widespread. The teaching of science draws upon a wide range of abstract concepts frequently used in explaining nature and natural phenomena, and supporting the teaching of science with technology has become crucial. As a result, a committed and continual effort is required for teachers to improve their professional development and excel in science teaching. Several studies have identified the affordances of incorporating technology into science teaching. For instance, Fakherji (2019) asserted that using technology-based learning tools can help teachers create interesting science lessons and support students in overcoming barriers that hinder their understanding of science. It is crucial to integrate contemporary technology into science training as it advances students'

comprehension and strengthens their science-process abilities while resolving the challenges related to teaching a science topic (Serevina et al., 2018). By integrating technology into science instruction, educators can provide students with various presentations, such as animations and simulations, that help them understand what is being taught. Furthermore, it helps students improve their scientific knowledge, encourages a solid understanding of scientific principles by harnessing the benefits of modern web designs, and facilitates the development of solid computer skills among students. Teachers now value the use of ICTs, and they are being incorporated into classrooms to increase student participation and make the learning process more interesting. However, ICTs can also become a distraction and a generally poor supplement to traditional teaching techniques if they are not integrated efficiently and purposefully into educational activities (Fakherji, 2019).

Teachers' acceptance of technology

People's attitudes towards technology are moulded by their experiences and culture, just as science is influenced by experiences and culture (Cullen & Guo, 2020). Thus, teachers' opinions and attitudes concerning technology use in the classroom become very significant in integrating ICTs in schools. Teachers' receptivity to technology and proclivity toward it are important factors in evaluating their willingness to accept its utility and use it in their educational practices (Njiku et al., 2019). In general, teachers who are optimistic about technology use are more likely to incorporate ICTs into their lessons (Harwood & Eaves, 2020). However, some teachers tend to be hesitant to use technology and frequently continue to use traditional teaching methods despite having access to ICT tools. When teachers do not have the expected views on technology, it can impact students negatively. Despite research indicating the benefits of using ICTs for learning, as well as various training programmes and school investments in ICT resources, ICT adoption in schools has unfortunately been slow (George & Ogunniyi, 2016). Researchers used the unified theory of acceptance and use of technology (UTAUT) paradigm to investigate science teachers' attitudes toward adopting ICTs in their teaching methods (Al-Zboon et al., 2021). The authors surveyed 195 science and mathematics teachers from public schools in southern Jordan. The findings revealed that teachers' attitudes toward integrating ICTs into their educational practices were influenced by their perceptions of performance and effort expectation, social influence, and facilitating conditions related to ICT. The authors attribute the positive perceptions (in all dimensions of UTAUT) of sampled teachers in integrating ICTs into their educational practice to the support provided by the government. Nonetheless, Serin and Bozdag (2020) note that teachers' views on the use of technology in teaching are influenced by their individual experiences and beliefs, which differ depending on their level of professional expertise. This influence shows that teachers' experiences with technology substantially impact their attitudes and views of its use in science teaching.

Factors that hinder and facilitate teachers' use of technology in teaching science

Teachers frequently encounter challenges when it comes to accepting and incorporating technology into education, particularly in the Global South. For instance, studies have indicated that factors influencing teachers' use of technology in science teaching appear in various ways and include external barriers. These barriers include a shortage of expertise in instructional design, insufficient training and guidance, scarcity of essential information and educational software, lack of motivation, unreliable electricity, unfavourable perceptions about the value of technology, pupils' weak information literacy, overcrowded classrooms, and teachers' limited time and difficulty in managing and promoting the use of technology device during science instruction, which may be owing to limited access to information, communications and technology resources due to schedule problems (Jita & Munje, 2020; Johnson et al., 2016). According to Johnson et al. (2016), these external constraints must be addressed at the institutional level, and most adjustments are gradual. Furthermore, science teachers confront obstacles in their use of technology for teaching and learning due to internal challenges such as resistance to technology use in the classroom, lack of confidence in skills and knowledge, lack of motivation, willingness to adapt to change,

teachers' attitudes and beliefs towards technology use (Jita & Munje, 2020; Johnson et al., 2016).

Another major challenge that impedes the use of technology in science education is the effective planning and engagement of school management (Tolba & Youssef, 2022). Failure to prioritise issues related to technology leadership in schools might lead to science teachers not using technology in their classroom instructions. This omission implies that the use of technology in teaching science seems to be situational. Various requirements must be met to support the use of technology in science teaching and learning to facilitate the use of technology in teaching and learning (Ghavifekr et al., 2016). These strategies include aligning ICT tools with learning objectives, treating them as a resource alongside others, providing professional training and technical guidance, ensuring easy access to equipment, and working to change teachers' negative attitudes toward using technology in the classroom. These strategies can help address various issues that science teachers, particularly in the Global South, might be facing. Similarly, research claims that teachers' use of ICTs in education is influenced by a lack of belief in the benefits of technology, a lack of personal confidence in using technology, insufficient institutional support, and insufficient computer equipment (Tolba & Youssef, 2022). Another study by Saal et al. (2020) found that facilitating situations, such as favourable teacher- and learner-IT technician ratios, dependable WiFi connection, high-quality subject-specific software, ongoing professional development opportunities specifically for integrating educational technology into science subjects, as well as online security measures, affect how science teachers use technology in their classrooms. Furthermore, research indicates that technological, pedagogical, and content knowledge (TPACK) functions as a superordinate moderator variable, significantly affecting the UTUAT model's design elements (Kyllönen, 2018). As a result, concepts related to TPACK, such as infrastructure, equipment, software, a lack of educational design, and inadequate training, have also been identified as conditions that limit science teachers' actual use of technology in teaching and learning (Davis, 1989; Ertmer et al., 2014; Kyllönen, 2018). The prevalence of these challenges continues to increase the digital divide in science education, particularly in developing countries. Therefore, it becomes important to understand the conditions that facilitate or limit teachers' actual use of ICTs in science teaching based on UTAUT.

Theoretical Foundations

Several studies have shown that the acceptance of technology can be viewed as a personal and/or societal process (Davis, 1989; Rogers, 2003; Venkatesh et al., 2003). As a result, different methodologies are used to understand the construct of technology acceptance. The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed by Venkatesh et al. (2003) by incorporating the research findings from eight previously developed models of technology acceptance: The Theory of Planned Behavior (TPB), the Theory of Reasoned Action (TRA), the Social Cognitive Theory (SCT), the Technology Acceptance Model (TAM), the Motivational Model (MM), the Combined TAM and TPB Model (C-TAM-TPB), the Model of PC Utilization (MPCU), and the Innovation Diffusion Theory (IDT). The UTUAT model is regarded as one of the most broadly used models for envisaging technology use in a variety of circumstances (Al-Mamary, 2022). According to the UTUAT model, teachers' actual use or intention to use technology is determined by their performance and effort expectancy, social influence and facilitating conditions, as well as hedonic motive, cost/perceived value and habit.

The term Performance Expectancy (PE) is described as the amount to which a person believes that using ICT will help enhance their job performance (Venkatesh et al., 2003). They further explained that performance expectancy has its roots in perceived usefulness, extensive motivation, job fit, relative advantage and outcome expectation. According to Venkatesh et al. (2003), Effort Expectancy (EE) relates to the degree of ease associated with the use of ICT, which is also interpreted as the perceived ease of use from TAM (Davis, 1989). Social Influence (SI) is the "degree to which an individual perceives how important it is that others feel or believe he/she should use technology" (Venkatesh et al., 2003, p.451). In this study, social influence is viewed as a science teacher's opinion on what other significant people

(such as their principal, subject-head and colleagues) think about their use of ICTs. Venkatesh et al. (2003) further defined Facilitating Conditions (FC) as "the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of technology" (p.453). The usage behaviour (actual use) is defined in this study as the science teacher's actual use of technology for teaching and learning. According to Venkatesh et al. (2003), the four determining constructs of the UTUAT model are influenced by moderators such as gender, age, prior experiences, and the voluntary nature of technology use, which have been shown to impact an individual's intentions to use and/or actual use of technology. Studies have also shown that the most critical factors affecting the acceptance of technological tools (smartphones and tablets) in education are the tendency or predisposition and effort expectancy (EE), performance expectancy (PE), social influence (SI), the voluntariness of use, facilitating conditions (FC), beliefs, personal technological skills, perceived capacity to learn new technologies, advantages related to pedagogy and learning technologies, environmental influences, resources of the use and commissioning, and self-management of learning (Aliaño et al., 2019; Ertmer et al., 2014; Kyllönen, 2018). The UTAUT model is used in this study to elicit a deeper understanding of the factors influencing teachers' actual use of ICTs for the teaching and learning of science. The study also explores the kind of technologies that science teachers use since it is believed that all teachers in public schools in the Lagos state have been encouraged to use some form of technology in their classrooms. Therefore, technology use in schools is not viewed as voluntary but rather as an obligation. Hence, the voluntary nature of technology use is not explored in this study. Moreover, the aim of this study was not to explore the moderators of technology acceptance; hence, this study has not investigated gender, age, and years of experience.

Methods

This study employs a qualitative research approach and case study design grounded in the interpretive paradigm to gain better insight into teachers' perceptions and experiences of using ICT in teaching science (Creswell & Poth, 2016). Semi-structured interviews were used to elicit data from six science teachers (three males and three females) from two public secondary schools situated in an education district in Lagos, Nigeria. The self-developed interview protocols were informed by existing research on the use of technology in science education. The protocol was peer-reviewed by two lecturers in science education and one secondary school teacher. The language of the interview questions was later refined based on the feedback received to ensure clarity and conciseness. The interview was conducted digitally using text-based WhatsApp communication that allowed asynchronous interactions, as well as real-time voice and video options. Detailed information about the research and consent was first sent to participants via WhatsApp text. All participants had to have at least five years of teaching experience and be willing to participate in the study voluntarily. Interview questions were later sent to participants individually via text, allowing them time to respond. These questions were followed by a one-on-one voice and video call to ask follow-up questions and seek clarification on their initial text-based responses. The interview questions explored teachers' thoughts about using ICTs to teach science, their experiences in relation to ICT use for teaching science, and possible challenges and barriers encountered in using ICTs for teaching science. The collected data was analysed using content analysis. Content analysis was deemed suitable as it helped the researchers systematically analyse and identify key texts/responses that reflect the teachers' perspective on using ICTs in science teaching (Gläser-Zikuda et al., 2020). The content analysis of collected data was systematically interpreted and sorted based on the study's theoretical background.

All interactions with human subjects were carried out per the institutional and/or national research committee's ethical guidelines and the 1964 Helsinki Declaration and its later amendments or equivalent ethical standards. In addition, research consent to participate in the study was obtained from sampled teachers. An email outlining the goals and objectives of the study was initially sent to a sample of 20 teachers specifically chosen to participate in the study. Teachers were asked to give their consent if they

were willing to participate in the study. However, only six teachers confirmed their willingness and permission, resulting in the sample reported in this study. All names have been changed for ethical reasons. The biographical information of participants is presented in Table 1. .

Table 1: Participants' Biographical information

Participant	Gender	Age	Years teaching experience	Subject taught
1	Female	39	11	Chemistry
2	Male	38	9	Chemistry
3	Male	40	12	Biology
4	Female	37	7	Physics
5	Male	38	11	Physics
6	Female	47	20	Biology

Results and Discussion

Participants' perceptions and experiences in the integration of ICTs in science teaching are discussed based on the UTUAT model. According to the UTAUT model, the perceived likelihood of teachers using ICTs to support science teaching depends on the direct effect of key constructs, including perceived efficacy, ease of use, social influence, and the availability of supportive conditions. Based on the findings, the researchers sought to assess if teachers had good or unfavorable opinions toward the use of ICTs in science education.

The first analysis is related to PE, which measures how much science teachers believe that introducing ICTs into the classroom will improve science teaching and learning. The researcher intended to determine whether or not science teachers considered using ICTs to support science teaching and learning as beneficial. The findings revealed that sampled science teachers perceived using ICTs in teaching science as beneficial to students.

"Using technology in science education allows students to gain a better comprehension of science concepts, gain a better perspective on real-world events, and improve their technological knowledge and reasoning skills" (P4).

In general, the use of technology in the classroom makes learning more enjoyable. Slow learners can make time to come and listen to previous sessions if I use it in my class the way I do. As a teacher, employing technology makes my job easier because I only have to perform a little work during revision class, and it has made my practical classes so engaging. (P5)

"While teaching science using technology, learning becomes more real and concrete for students, who also learn more quickly and more easily" (P6).

"Allowing my students to bring their gadgets to class has taught them how to control their phones to access the class content, as well as how to use various blogs and channels to their benefit" (P2).

"It helps to develop students' 21st-century skills like teamwork (P1)."

Interview responses from participants indicate that using technology in science education is presumed to be extremely beneficial for both students and teachers because it greatly increases students' understanding of scientific topics and their attention, keeps them engaged, and encourages active involvement in science activities (Fakherji, 2019). Furthermore, technology is used to administer assessments and deliver courses.

The second analysis is on effort expectancy, related to how teachers assess the ease with which ICTs may be used for science teaching

and learning. This perception may impact their decision to adopt ICTs in the classroom. Looking at teachers' experiences in using technology, five teachers indicated that they felt successful while using technology as a learning support tool in their science classroom, as indicated by P2, P3, P4, P5, and P6. For instance, P4 indicated that using technology made her work simpler and exposed students to comprehensive knowledge compared to what she might give them as a teacher. She further clarified that using technology often made the teaching and learning process easier for her students, as they had to see the images of what they were taught. This point was also reinforced by P6 when she said:

I observed that every time I use any technology for teaching in my class, the students are always happy because it becomes easy for them to visualise what I am teaching, and this also increases their level of participation and concentration. (P6)

In addition, P5 indicated using digital technologies in his science classroom was somehow challenging at first, but he later got used to it. In contradiction to the view of the five participants, P1 seemed to experience the use of technology negatively when she mentioned: "Using technology in class is not that easy because most students are not able to access the WhatsApp group because of their inability to get a mobile phone" (P5). These responses show that teachers have a positive perception towards using technology in teaching science, and these perceptions are due to their belief that technology is beneficial to their work and their students, as well as the perceived convenience of using ICTs for lesson presentation, supporting the findings of Park et al. (2016). Further probing into teachers' perceptions of the use of technology in science teaching found that the sampled teachers echoed in some way that they rarely use ICT tools to support the teaching and learning of science. In addition, whenever ICTs are being used, they are not perceived as pedagogically coherent to support students in science practices. For instance, P2 stated,

I rarely use technology in my class, but anytime I use it, is either for lesson presentation via a projector or for sending video lessons from YouTube to students and use it for class discussion, but that is not frequent as well. (P2)

Along these lines, P1, P4 and P6 also indicated that they rarely use technology in their science classroom. P4 explained:

I only use technology in my class when I have what is required to use it and [it] happens like perhaps, I say, once a week. For instance, the other time I used a laptop in my class was when I taught fibre optics. I had to go online to look for information that could aid my lesson preparation since I had no instructional material as a teacher. So, I was able to get a lot of pictures, which enhanced my teaching and also had to give students assignments that required them to go online and read more on the topic (P4).

On the other hand, P3 and P5 indicated that they use ICTs more often in their classroom when teaching science. P3 said: "I use it very often, particularly for projection of my audio-visual instructional aid during biology lessons, and mostly I use my laptop for computation of students' results". P5, on the other hand, stated:

I use it for my daily teaching and can play back what I taught the students. I also use it to record my teaching before going to class and sometimes play it during the lesson or whenever the students request for it. (P5)

Analysis of participants' responses shows that all the teachers use ICTs mostly for lesson presentation, including showing learners pictures and/or videos to support the science concept being taught. However, none of them mentioned using technology to promote scientific inquiry skills or inquiry-based learning among their students.

Knowing what technological tools and resources teachers utilise in their classrooms helps to unveil why they are using them and what is influencing teachers to use them. It is interesting to note that teachers indicated the types of technological tools and resources they used included computers, laptops, smartphones and tablets, digital cameras, projectors, and interactive whiteboards. P4 mentioned how she uses her laptop and mobile phones to prepare lessons and teach topics such as fibre optics due to a lack of instructional materials. P3 added that she specifically uses the computer system in the resource room in her school to access websites and

video streaming for biology lessons. P5 also shared that he uses an interactive board, smart board and computer. In addition to using mobile phones and computers, P2 indicated that he uses YouTube and social media platforms like Facebook and WhatsApp Messenger for lesson presentations and class discussions.

However, none of the teachers seems to have a strategic knowledge of how to use technological applications pedagogically or software as an inquiry tool to enhance science instruction, as this was not mentioned. These omissions suggest that participants have poor knowledge about the repertoire of technologies specifically designed or used for science teaching. These responses further indicate that the degree to which teachers use technology to support science teaching in their classrooms depends on their ownership of technological devices (Yerdelen-Damar et al., 2017). These findings support the arguments made by Lim et al. (2020), who emphasise that developing countries face challenges in integrating ICT into their education systems mostly due to a lack of skilled workers. Based on these arguments, teachers must begin to shift their ideas and design effective strategies for using appropriate technological tools to improve science instruction. These approaches need to be consistent with the goal of developing students' scientific inquiry and problem-solving abilities.

The third analysis is on facilitating conditions, which are viewed as a science teacher's belief that there are sufficient skills, knowledge, resources, and administrative and technical assistance to enable their use of ICTs for science teaching and learning. Although the teachers pointed out that they were trained on using digital technologies to support their classroom teaching, the training does not seem effective as teachers mentioned students' inadequate access to technical resources as one of the biggest challenges experienced when using technology in their science classrooms. For instance, P4 explained that she has yet to understand how students learn with technology because few of her students have the devices and those who do have the devices don't know how to use them appropriately for academic purposes. "We are not able to use simulations for teaching important physics topics because imagine in a class of 70, only 4 to 5 students can afford data, and only 10 have devices" (P4).

This statement also corresponds with P1's challenging experience. P4 further indicated that the school does not have technological equipment and does not encourage students to bring their devices, making it difficult to equip students with some technological and scientific skills peculiar to our changing environment. These responses suggest that teachers are not able to use innovative educational technologies to support science teaching due to inadequate available technology or a lack of access to ICT resources for both teachers and students (Jita & Munje, 2020; Lim et al., 2020). This lack of resources is a major concern for the quality of science education and equitable opportunities provided for students in Nigeria and other developing contexts in the Global South to learn science (Jita & Munje, 2020; Lim et al., 2020). In addition, participants' responses to the kind of training and support received for implementing technology in science classrooms seem to be more focused on a generic application of technology and not on the needs and content of the teachers and/or the syllabus. This interpretation was supported by P1 when she said:

There is no support at all from anywhere on how to effectively implement or use digital technologies as learning support tools for teaching science. But we are receiving training, which unfortunately is not effective because students don't have devices to work with. More so, the training is focused on the general use of technology and not particularly focused on science teaching. (P1)

Furthermore, P2 indicated that he feels supported to some extent. However, in most cases, they are left alone to adapt whatever training they were given to their classroom context, which is sometimes not very easy to do. These findings indicate that teachers believe the support they receive is not effectively channelled to address their actual classroom situation (Al Bataineh & Anderson, 2015), consequently leading to a lack of a supportive environment. These results align with the findings of Kayalar (2016), who says that technology in the learning programme can only succeed if teachers are educated, competent, and given adequate access to digital technologies. The teachers also mentioned the ineffective funding

process from the government, unreliable electricity supply, inadequate and insufficient technological resources in the school, no data accessibility for students and teachers, large classroom size and student-related factors. The student-related factors included very poor responses on the part of the students, lack of access to devices, and distraction of students by the smart board, which are some of the challenges experienced when using technology to support science teaching and learning. For instance, P5 said: "I am always faced with the challenges of [the] distraction of students by the smart board". These findings supported previous research by Saal et al. (2020) that found that a lack of facilitating conditions in schools impacts teachers' intention and/or limits their actual use of technology. The lack of these facilitating conditions has also been identified as a significant factor contributing to the failure and unsustainability of many technology initiatives and training programmes in Global South countries (Lim et al., 2020). Furthermore, the concerns expressed in this study are in line with the findings of previous research on the use of technology in science teaching and learning in a similar context within the Global South (Jita & Munje, 2020; Lim et al., 2020).

Conclusion

In interpreting the results of this study, it is essential to acknowledge the exploratory nature of the research design and the modest sample size of six participants. The intention behind this study was not to make definitive claims about the broader population but, rather, to provide insights in the context of how Nigerian science teachers integrate technology in their classroom. The results presented in this study showed that the sampled science teachers appreciated the power of technology and its impact on students understanding of science. Whilst teachers have a positive perception towards the use of technology (performance expectancy and effort expectancy), they still demonstrate a traditionally oriented practice when using technology to support the teaching and learning of science. Although teachers mentioned that they use a variety of technologies such as mobile technology, social media, websites, smartboards, and computers to support science teaching and learning, findings show that teachers lack adequate knowledge of assistive technologies that can be used to enhance the teaching and learning of specific science contents. Regarding facilitating conditions, teachers stated that their professional development training did not provide sufficient information about the approaches and strategies that can be used to plan technology-oriented science instruction. Teachers also stated that they and their students lack access to technical tools such as software and applications that can be used to improve science teaching and learning. Despite commendable efforts and diverse initiatives, the results of the study reveal that the digital divide in education continues to widen and strengthen inequality in the socioeconomic status among students and teachers. Results also revealed that the sampled science teachers would like to use technology such as laptops or computers, science software and data projectors more often to support their teaching. However, they encounter problems such as large classroom sizes, student digital distraction, problems with electricity supply, lack of access to internet connectivity, ICT hardware and software for science teaching, and ineffective government funding and support for technology in schools when using technology to support science teaching.

Limitations of the Study

Due to the small sample size used within one local education district, the findings of this study should not be generalised to all science teachers. However, this study was not aimed at generalising the findings but rather to give insight into the experiences of these secondary school teachers in their integration of ICT to support science teaching in Nigerian classrooms. This approach gave the researcher leverage to study the cases in depth, as it was not the intention to unearth the actual practice of all teachers in Nigeria. Another limitation of this study is that findings were drawn based on participants' self-reports, which might be subjective. Thus, it is suggested that future research could include observations to understand how teachers use technology to support science teaching.

Contributions of the findings to knowledge

This study contributes to the body of knowledge regarding the current perspectives and practices of science teachers in the Global South context when it comes to utilising technology in

their instruction. It also looks at the factors that limit and encourage the use of technology in science teaching. From the findings of the study, it can be concluded that teachers believe their use of technology as a teaching aid is valuable in addressing learners' needs and strengthening the teaching and learning of science. The results of this study also provide insightful information that can guide future plans for effectively incorporating technology into science teaching, particularly in the context of the Global South. Furthermore, our findings provide insight into the intentions that science teachers have for integrating technology into their practices. These insights can be utilized to create techniques and plans that encourage successful technology integration in science education within developing countries.

Recommendations

While teachers are provided with opportunities for professional development in technology usage, these programmes must go beyond simply familiarising them with accessible technologies and general usage. Instead, they should focus on instructing teachers on how to utilise technology strategically and pedagogically to improve problem-solving and foster the development of scientific skills. In addition, government, school management and other educational stakeholders should provide schools with functioning computer laboratories, connectivity, and other technological resources that could give teachers and students unlimited and effective access to the use of ICTs for teaching and learning science. Furthermore, there is a need for educational stakeholders to engage more closely with teachers on how to use technology in teaching effectively. It is also important that school-based policies or programmes that allow students who already own devices to bring them to school for classroom learning are put in place. This will reduce issues related to the lack of technological tools in schools. Additionally, to achieve effective technology integration in science teaching within the Global South context, it is recommended that all relevant educational stakeholders actively participate in the formulation of policies that guarantee the equitable provision of access to technology and digital learning materials for all students and teachers within the country regardless of their location and socioeconomic status.

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Disclosure statement

The author declares that there is no conflict of interest

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