SCIENCE EDUCATORS' ACCESSIBILITY AND USABILITY OF EMERGING TECHNOLOGY FOR TEACHING SENIOR SCHOOL STUDENTS IN KWARA STATE, NIGERIA

BY

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Abstract

This research investigated the extent to which science teachers in Kwara State, Nigeria, can access and effectively use emerging technologies in teaching senior secondary school students. A descriptive survey methodology was adopted, utilizing a validated questionnaire administered to 375 science teachers across five local government areas within Ilorin Metropolis. The study revealed that artificial intelligence emerged as the most accessible and usable technology, with mean scores of 3.0373 and 3.0533, respectively, highlighting its role in personalized learning and intelligent tutoring systems. Conversely, technologies such as augmented reality, virtual reality, and 3D printing demonstrated low accessibility and usability, reflected in mean scores below 2. The analysis indicated that overall accessibility and usability of these technologies were comparable, with identical mean scores of 2.71 and no significant difference ($p = 0.90$). These findings highlight the pressing need for interventions to facilitate the adoption of emerging technologies in science education. To address these challenges, the study recommends investments in technology infrastructure, collaborations with technology providers, and the introduction of subsidized programs to improve access. Additionally, capacity-building initiatives, including professional development and practical training for educators, are essential for enhancing their competency in using these technologies effectively. Raising awareness and providing hands-on experience are critical to overcoming barriers and optimizing the potential of these tools for transformative teaching and learning outcomes.

Keywords: emerging technology, science education, accessibility, usability, Kwara State.

Introduction

In Nigeria, more and more science teachers see incorporating modern technologies into science instruction as a necessity rather than merely a choice. This viewpoint is a result of the significant impact that technology has on education, especially in light of changing learning settings, the need for flexible teaching strategies, and the requirement that science education foster creativity and innovation. In senior secondary school in Nigeria, the use of modern technology in science instruction has become so widespread that it is changing the way science education is structured and organised, as well as how well Nigerian science teachers perform. Flexible teaching scheduling and enhanced contact between scientific teachers and students outside of the classroom are made possible by the adoption and usage of developing technologies (Oliveira et al., 2019). Emerging technologies improve the quality of resources, interactions, and teaching methods while also expediting the teaching and learning process in science education (Onyema, 2020). Information technology has become an essential resource since its lack can result in ignorance, poor decisions, and ultimately business loss (Onyema, 2020). Every industry, including banking, aviation, education, healthcare, law, and security, depends on technology, claim Jawad et al. (2014). Emerging technology is defined by De Alwis et al. (2021) as technological advancements, applications, and innovations that are still in the early stages of development, have the potential to significantly affect society, and are expected to be widely adopted in the near to medium long term. According to Kroon, do Céu Alves, and Martins (2021), emerging technologies include innovative new applications for pre-existing technology as well as those that are new and whose use is growing.

Since these technologies present businesses with both opportunities and risks, they must be regularly observed and evaluated. Emerging technologies are constantly changing. Examples include wearable devices with sensors and head-mounted displays, virtual and augmented reality (VR/AR), artificial intelligence (AI), and the Internet of Things (IoT), which is made possible by the quick 5G mobile standard. Together with other unexplored emerging technologies, these breakthroughs are promoting the creation of new digital ecosystems powered by the data produced by the massive online interactions between people and their gadgets (Riina, Yves & Cabrera, 2020). More dependable and efficient learning environments have been produced as a result of the incorporation and use of well-known technologies like cloud computing, augmented reality, virtual reality, artificial intelligence, and the Internet of Things in educational systems. Secondary schools throughout the world are progressively integrating these new technologies into their official and informal teaching and learning processes, frequently with the help and support of students who are already accustomed to using them. Emerging technologies provide a more individualized, flexible, and varied approach to addressing individual learning needs and pedagogical methodologies, giving students more freedom and choice in contrast to conventional teaching approaches that are teacher-centric and uniform (Hawthorn, 2018). Innovations, methods, and discoveries that are used in a variety of educational contexts and objectives are known as emerging technologies. As a result, using new technologies to improve instruction necessitates institutional resources for funding, evaluating, and rewarding innovative teaching strategies. Though many colleges struggle to comprehend and adopt new advancements, the development of educational technologies has been accelerating for more than a decade.

Almufarreh and Arshad (2023) outline significant new educational technology that teachers and administrators must be aware of in order to ensure that senior secondary school students receive a top-notch education. The first new technology is virtual reality. With the use of interactive computer-generated experiences and an artificial digital area, virtual reality (VR) technology creates a simulated environment. It can create a realistic environment that mimics the real world or a dream world that allows experiences beyond the limitations of everyday physical reality. Developments in the 1960s are when virtual reality (VR) had its start (Sun, Wu & Cai, 2019). In education, virtual reality (VR) technology provides a novel approach to learning that typically enhances the conventional approach. This innovative strategy increases students' interest in learning new techniques that use sensory information.

More accurate depictions of operations or activities can be achieved through the use of virtual reality (Smutny, 2022). One of the main benefits of using virtual reality (VR) in the classroom is its ability to help students understand and investigate complex or abstract ideas in a secure setting (Bourhim & Cherkaoui, 2020; Morélot et al., 2021). Students can explore places that might not be available to them otherwise through computer-generated simulations. Through interactive interaction, virtual reality (VR) immerses users in computer-generated environments with the goal of increasing simulation realism and improving the overall effectiveness and impact of educational experiences. Augmented Reality (AR) is yet another important technical breakthrough. AR creates an integrated perspective by superimposing digital visuals on top of real-world surroundings. As more smartphones and other AR-capable gadgets become available, its significance is anticipated to increase.

There are a number of significant differences between Virtual Reality (VR) and Augmented Reality (AR), according to Charles McLellan. While VR can create an infinite number of virtual worlds, it only offers users experiences that are spatially limited, and using a state-of-the-art immersive VR system effectively usually requires a powerful computer (Lozano, 2018). AR, on the other hand, requires a certain amount of mobility in the outdoors. By providing three-dimensional representations of items, AR can improve conventional learning and comprehension. For example, medical students can see a 3D model of a heart (Tzima, Styliaras & Bassounas, 2019). AR aims to improve comprehension by showing objects that are difficult to recreate in real life. But the goal goes beyond just making learning more interesting and pleasurable. Numerous augmented reality (AR)-focused studies in the field of education have yielded consistent findings: The method, effectiveness, and motivation of learning could all be improved by AR applications (Osadchyi, Valko, & Kuzmich, 2021). The third new technical advancement is artificial intelligence. Researchers have been trying to improve computers' capacity for autonomous learning since the 1950s, when they first needed application manipulation to operate. This development signifies a radical shift in

computer science, business, and society. In a way, computers can currently perform new tasks by themselves (Doshi-Velez & Kim, 2017). In order to adapt and recognize their cues, artificial intelligence (AI) will communicate with apps using their own language, emotions, and gestures.

Because a number of intelligent terminals are popular and connected, people will live in real physical space while still being a part of the digitally virtualized network. Science fiction has been predicting for decades that the widespread adoption of artificial intelligence would lead to dramatic and potentially disastrous changes, but in spite of these predictions, AI has slowly permeated many aspects of our daily lives. AI has the potential to revolutionize and improve every sector, including education, and thus improve our everyday experiences. In education, artificial intelligence is beginning to have an impact, and conventional approaches are undergoing significant change. Additionally, new technologies are changing how education is taught and acquired. In education, artificial intelligence (AI) is a quickly developing topic with a lot of exciting promise. These include customized instruction, flexible evaluations, and the capacity to encourage significant participation in online, mobile, or hybrid learning environments.

The fourth developing technology is the Internet of Things (IoT). A network of linked computers, digital and mechanical devices, items, people, and animals that may share data over a network without requiring communication between computers or between applications is referred to as the "Internet of Things" (IoT). IoT and the potential for higher revenues, lower operational costs, and improved efficiencies are what motivate businesses. Interest in the IoT domain has increased across a number of industries. Consumer goods, business, healthcare, manufacturing, education, and research are just a few of the industries that use IoT to enhance vital business processes. To enhance teaching and learning capabilities, the education industry is investigating innovative digital infrastructure. The Internet of Things has made it easier to improve the learning environment, even in more complex domains like science, math, engineering, etc. Internet of Things devices can improve lab and lecture hall teaching methods to boost student engagement more rapidly and effectively (Al-Emran, Malik & Al-Kabi, 2020).

The last new technology discussed in this study is cloud computing. The term "cloud computing" describes a system in which all data processing and storage functions are managed by databases and external servers (Almufarreh & Arshad, 2023). This paradigm provides dynamic and scalable computer resources, including processing power and storage, and is delivered as an Internet-based service. Due to its ease of deployment, management, scalability, security, and other related advantages, cloud computing has spread throughout many information technology domains. Rather of hosting programs on their premises, which would involve the expenditures of creating and maintaining networks, organizations are increasingly using cloud data centres (Qasem et al., 2019). These days, a lot of private institutions rely significantly on information technology to fulfil their operational needs. Both teachers and students can usually access these services using web browsers and other Internet-connected devices. They are either provided for free or at drastically lower charges, and they frequently offer better accessibility than what the educational institution can offer. Through the Internet and cloud computing, users may access and manage data. Every employee in the company has a distinct login for the work they are allocated, which connects them to the cloud. Using computers and other electronic devices, students can access their teachers' educational materials online at any time, both at home and at school. Lessons, homework, and tests can be uploaded by teachers to the cloud server. Senior school teachers can identify areas where students frequently make mistakes by looking over their students' study logs.

As a result, teachers will be free to develop their own instructional materials and methods. This will allow teachers to enhance their resources and techniques of instruction (Margianti & Mutiara, 2015). The purpose of this study is to investigate how Nigeria senior secondary school scientific instructors use science instruction. Science is a systematic way to acquire reliable knowledge about nature and natural phenomena through rigorous observation and experimentation (Abidoye, 2018). It can also refer to a body of knowledge, a method for studying natural phenomena, and a way to make decisions in an attempt to understand nature, claim Badmus, Amuda, and Bada (2020). Science receives a lot of attention in education due to its significance to society and everyday life, as it is a

significant endeavour that nations rely on to advance technologically (Okoro et al., 2022). The availability and use of materials that tend to enhance scientific education and learning are required by scientific and technical advancements (Abidoye, 2018). Therefore, helping people comprehend and value scientific concepts is a critical function of science educators. They make the material interesting and relatable in addition to stimulating students' thinking by questioning their assumptions. Teachers have a lot of duties in the field of science education, and they play a particularly important role in creating learning opportunities for students studying science-related subjects. For instance, they need to understand how students learn, be proficient in their fields of knowledge, and be able to use a variety of teaching methods and strategies (Kalagbor, 2022). Additionally, it is well acknowledged that a lecturer's teaching style and subject-matter experience are crucial in assisting students in achieving success (Jacob et al., 2020).

The quality of education in any given country is determined by the characteristics of educators and their attitude towards their work. Therefore, teachers who possess specialized knowledge in a particular field should be more productive than those who do not. This is because educators face challenges when they try to establish a learning environment in areas in which they lack the pedagogical and topic understanding that they need (Filgona & Sakiyo, 2020). teachers are considered the basic tools. Abidoye (2018) asserts that although a teacher's quality has a big influence on a student's academic performance, only a small number of specific teacher attributes significantly affect classroom results. The qualifications of science instructors have an impact on students' performance, but teaching experience has no effect, according to researchers (2020) who examined teacher experience and credentials as markers of attitudes towards teaching science. Teaching experiences are a crucial component of science education. A person's level of motivation or inclination to engage in a specific behaviour is described by their behavioural intentions (Moorthy et al., 2019). Ajzen (2020) defines behavioural intention as the agent's perceived probability of performing the behaviour. It captures the individual's motivation or desire to perform a particular action. Behavioural intentions are influenced by a variety of factors, including as attitudes, self-efficacy, subjective standards, and ethical cognition (Cao et al., 2021). These factors have a significant impact on how someone intends to behave and can influence their actions and decision-making process (Cao et al., 2021). Understanding behavioural intentions is crucial in a variety of contexts, including predicting human behaviour in driving situations, improving the quality of care in medical settings, and encouraging the adoption and use of technology (Gansser & Reich, 2021).

By looking at behavioural intentions, researchers can gain a better understanding of the factors that affect human behaviour and develop strategies to promote desired behaviours or outcomes. Both Hagger (2019) and Niemiec et al. (2020) distinguish six different types of conduct intention. An individual's attitude towards a behaviour, or attitude intention, reflects their intention to engage in that behaviour. Regular exercise may be valued and seen as beneficial by someone who has a strong attitudinal purpose to work out regularly. Personal criteria Intention: This describes how a person's intention to act in a certain way is impacted by both real and perceived social norms. If someone feels that their peers or family expect them to recycle, they may have a subjective norm intention to do so. Behavioural Control Perceived The term "intention" describes how confident a person is in carrying out their activities and how much control they feel they have over them. For example, someone who wants to establish their own business might believe they have the skills and resources needed to launch a small enterprise.

Conversely, the intention of injunctive norms refers to a person's view of what authority figures and other influential people believe to be proper or improper behaviour. If a student believes that their teachers highly disapprove of their cheating on tests, they may have an injunctive norm intention to abstain from cheating. Descriptive norms are used to investigate how individuals view the prevalence of particular behaviours among their peers. If someone believes that a large number of their friends volunteer regularly at community activities, they may have a descriptive norm intention to volunteer as well. The term "habitual intention" describes behaviours that are automatic, recurrent, and usually performed without conscious thought. An example of a habitual intention for dental hygiene would be someone who brushes their teeth without thinking about it each morning (Hagger, 2019; Niemiec et al., 2020).

Several obstacles to the use of contemporary technology were examined in a research by Onyema (2020) that concentrated on the integration of new technologies in the Nigerian educational system. The study collected secondary data from literature reviews in addition to structured questions. Participants, who included instructors and students from public and private secondary schools as well as universities in southwest Nigeria with comparable infrastructural levels, were given two hundred questionnaires. The collected information was analysed using descriptive statistics. According to the results, most respondents concurred that incorporating new technology into the classroom improves and revitalises instruction, encourages diversity, and helps students reach their learning objectives.

According to Agwu's (2020) research, which examined the effects of a TPDP on university lecturers' knowledge levels and use of modern technologies in scientific education. Descriptive survey design was employed in the study. Participants in the Advanced Digital Appreciation Programme for Tertiary Institutions (ADAPTI) from 2015 to 2018 included 457 scientific instructors from three higher education institutions in Ebonyi State. 125 lecturers, 72 of whom were men and 53 of whom were women, were chosen from the population to comprise the sample using a stratified random sampling procedure. The researcher developed a structured questionnaire to gather data, which was assessed by three specialists in the field of scientific education. Using Cronbach Alpha to evaluate the items' internal consistency, reliability scores for the two clusters combined were.76, while reliability values for questionnaire clusters A and B separately were.81 and.78.

Although teachers' familiarity with modern technology had increased after the TPDP, they had not yet fully integrated these tools into their lesson plans, according to the study's findings, which included both qualitative and quantitative analyses of the data collected. Additionally, there was no discernible difference between male and female lecturers' comprehension and use of modern technology in the classroom following the TPDP. The study suggested, among other things, that education institutions regularly engage their teachers in TPDP to help them make better use of modern technology in the classroom and raise student achievement. Thus, this study is a continuation of the investigation of how science educators accessed and used the emerging technology for teaching at senior secondary school in Kwara State, Nigeria.

Purpose of the Study

The main purpose of this study was to investigate the science educators' accessibility and usability of emerging technology for teaching senior school students in Kwara State, Nigeria. Specifically, the study was to:

1. determined the accessibility of emerging technology among science educators' for teaching senior school students in Kwara State;
2. find out the usability of emerging technology among science educators' for teaching senior school students in Kwara State;
3. find out the significant difference between accessibility and usability of emerging technology among science educators' for teaching senior school students in Kwara State.

Research Questions

1. What is the accessibility of emerging technology among science educators' for teaching senior school students in Kwara State?
2. What is the usability of emerging technology among science educators' for teaching senior school students in Kwara State?

Research Hypotheses

$H0_1$: There is no significant difference between accessibility and usability of emerging technology among science educators' for teaching senior school students in Kwara State.

Methodology

This study employed a descriptive research design of the survey type. The study collected data that was used to answer the research questions. The responses from respondents on the questionnaire on accessibility and usability of Emerging Technology were used to determine accessible and usability the Emerging Technology are for teaching science education subject (Chemistry, Physics, Biology, and Mathematics) in Ilorin Metropolis, Kwara State. The population of this study was 1,050 senior secondary school teachers in Ilorin Metropolis, Kwara State while the target population was 375 senior secondary school science teachers in Ilorin Metropolis. In this study, a multistage sampling procedure was used. First, twenty secondary schools was selected using a purposive sampling, with four schools selected from each of the five local governments within Ilorin Metropolis. Then, secondary school teachers from grades 7-15 was selected using a stratified sampling. Random sampling was used to select 40 science educators' from Asa, 69 science educators' from Ilorin East, 95 science educators' from Ilorin South, 135 science educators' from Ilorin West and 36 science educators' from Moro Local Government, resulting in 375 respondents.

The higher number of Chemistry teachers from Ilorin West is due to it being the most populous local government with the most secondary school teachers in Ilorin Metropolis. The instruments for this study was a researcher-designed questionnaire titled accessibility, and usability of Emerging Technology among senior school science educators' in Ilorin Metropolis, Kwara State (AUETTSSSE). The questionnaire comprised of two sections. Section A deals with the demography information about the respondents, such as their school name, gender, and area of specialization. Section B contains three parts: B1 contains the accessibility rate, and B2 contains the usability of Emerging Technology for teaching among science educators' in secondary schools. The instrument on Accessibility rate and Usability level of Emerging Technology among secondary school science educators' in Ilorin Metropolis, Kwara State (AUETTSSSE) was validated by three lecturers from the Department of Science Education, Al-Hikmah University, Ilorin, Nigeria.

The observation and correction of the lecturers were reflected on the final draft of the instrument. The instrument was subjected to a pilot study of 40 secondary school science educators' outside the locale of the study (Ifelodun Local Government Area) of Kwara State. The reliability scores of 0.78 and 0.84 of each of the sections of the instrument were ascertained using Cronbach Alfa Coefficient at 0.05 level of significance. The collected data was analyzed using descriptive and inferential statistics. All research questions were answered using descriptive statistics of mean, frequency counts and standard deviation. While the formulated research hypotheses was analyzed using the independent t-test. The Statistical Product and Service Solution (SPSS) was used to analyze the data at 0.05 level of significance.

Results and Interpretations

Table 1:
Accessibility of emerging technology among science educators' for teaching senior school students in Kwara State.

SN	ITEMS	HA	MA	SA	NA	MEAN	ST.D
1	Virtual Reality	8 (1.5%)	102 (19.3%)	169 (32.0%)	96 (18.2%)	1.9413	0.88200
2	Augmented Reality	6 (1.1%)	154 (29.2%)	156 (29.5%)	59 (11.2%)	1.7147	0.84301
3	Artificial Intelligence	193 (36.6%)	133 (25.2%)	26 (4.9%)	23 (4.4%)	3.0373	0.76256

4	Online Simulations	6 (1.1%)	154 (29.2%)	156 (29.5%)	59 (11.2%)	1.7147	0.84301
5	Blockchain Technology	4 (0.8%)	93 (17.6%)	198 (37.5%)	80 (15.2)	1.9440	0.80866
6	3D Printing	0%	80 (15.2%)	217 (41.1%)	78 (14.8%)	1.9947	0.74995
7	Internet of Things	10 (1.9%)	173 (32.8%)	130 (24.6%)	62 (11.7%)	1.6507	0.88290
8	Mobile Learning Apps	0%	102 (10.3%)	157 (29.7%)	116 (22.0%)	1.6773	0.85274
9	Gamification	8 (1.5%)	158 (29.9%)	130 (24.6%)	79 (15.0%)	1.7467	0.90926

Source: Field Work

The findings highlight varying levels of accessibility to emerging technologies among science educators teaching senior school students in Kwara State. Virtual reality, with a mean score of 1.9413 and a standard deviation of 0.88200, exhibits low accessibility, as only 1.5% of respondents rated it as "Highly Accessible," while a larger group (32.0%) considered it "Somewhat Accessible." Similarly, augmented reality has limited accessibility, as indicated by its mean score of 1.7147 and standard deviation of 0.84301, with just 1.1% of educators marking it as "Highly Accessible." Artificial intelligence emerges as the most accessible technology, achieving the highest mean score of 3.0373 and a standard deviation of 0.76256. A significant proportion of respondents (36.6%) rated it as "Highly Accessible," pointing to widespread utilization among educators. In contrast, online simulations share the same mean score (1.7147) and standard deviation (0.84301) as augmented reality, reflecting similarly limited accessibility in classroom settings. Blockchain technology shows slightly better accessibility, with a mean of 1.9440 and a standard deviation of 0.80866. However, it remains underutilized, as only 0.8% of respondents rated it "Highly Accessible."

3D printing demonstrates relatively higher accessibility compared to other tools, achieving a mean of 1.9947 and a standard deviation of 0.74995, with 41.1% of educators indicating it as "Somewhat Accessible." The Internet of Things is the least accessible technology, as reflected by its mean score of 1.6507 and standard deviation of 0.88290, with only 1.9% of respondents marking it as "Highly Accessible." Similarly, mobile learning apps show minimal accessibility, with a mean score of 1.6773 and a standard deviation of 0.85274, as no educators rated them as "Highly Accessible." Gamification, with a mean of 1.7467 and a standard deviation of 0.90926, also displays restricted accessibility, as only 1.5% of respondents rated it "Highly Accessible," while 29.9% marked it as "Moderately Accessible." These results suggest that while artificial intelligence is relatively well-integrated, most other emerging technologies face significant accessibility challenges, indicating the need for strategic interventions to enhance their adoption in science education.

Table 2:
Usability of emerging technology among science educators' for teaching senior school students in Kwara State.

SN	ITEMS	HA	MA	SA	NA	MEAN	ST.D
1	Virtual Reality: Immersive experiences that enhance understanding of complex scientific concepts.	8 (1.5%)	156 (29.5%)	141 (26.7%)	70 (13.3%)	1.8280	0.78464
2	Augmented Reality: It is use to Overlays digital information onto the real	8 (1.5%)	148 (28.0%)	147 (27.8%)	72 (13.6%)	1.5173	0.78358

	world, allowing for interactive learning experiences						
3	Artificial Intelligence: Is use to enables personalized learning, adaptive assessments, and intelligent tutoring systems in science education.	235 (44.5%)	100 (18.9%)	26 (4.9%)	14 (2.7%)	3.0533	0.67208
4	Online Simulations: Interactive computer-based models that is use to simulate scientific experiments or phenomena.	0%	91 (17.2%)	200 (37.9%)	84 (15.9%)	1.9813	0.68379
5	Blockchain Technology: Is usable by Enhancing transparency and security in scientific research and data sharing.	0%	75 (14.2%)	205 (38.8%)	95 (18.0)	1.8547	0.88323
6	3D Printing: Is usable by Creating physical models of scientific structures, facilitating hands-on learning and experimentation.	0%	198 (37.5%)	81 (15.3%)	96 (18.2%)	1.7253	0.89556
7	Internet of Things: It is used to Connects scientific equipment and devices, fostering real-time data collection and analysis.	8 (1.5%)	160 (30.3%)	134 (25.4%)	73 (13.8%)	3.0400	0.68677
8	Mobile Learning Apps: Is usable by providing on-the-go access to science educational materials, quizzes, and interactive content.	0%	132 (25.0%)	141 (26.7%)	102 (19.3%)	1.9200	0.78693
9	Gamification: Is usable by introducing game elements into science education to increase engagement and motivation	8 (1.5%)	156 (29.5%)	132 (25.0%)	79 (15.0%)	1.8520	0.80761

Source: Field Work

The results in Table 2 highlights diverse levels of usability for emerging technologies among science educators teaching senior school students in Kwara State. Virtual reality, with a mean score of 1.8280 and a standard deviation of 0.78464, exhibits moderate usability. While 29.5% of educators deemed it "Moderately Usable," a mere 1.5% rated it "Highly Usable," suggesting that its capability to provide immersive experiences for understanding complex concepts is underutilized. Augmented reality, which overlays digital information onto the real world for interactive learning, scored lower with a mean of 1.5173 and a standard deviation of 0.78358. Despite 28.0% of respondents finding it "Moderately Usable," its adoption remains limited, as only a small fraction considered it "Highly Usable." Artificial intelligence emerged as the most usable technology, with a mean score of 3.0533 and the lowest standard deviation of 0.67208. A notable 44.5% of educators rated it "Highly Usable," showcasing its effectiveness in supporting personalized learning, adaptive assessments, and intelligent tutoring systems.

Online simulations, used to simulate scientific experiments interactively, recorded a mean usability score of 1.9813 with a standard deviation of 0.68379. Despite 37.9% marking them as "Somewhat Usable," their application in classrooms remains modest. Blockchain technology, known for enhancing transparency and security in research, received a mean score of 1.8547 with a higher standard deviation of 0.88323. While 38.8% of educators found it "Somewhat Usable," its integration into educational practices appears limited. 3D printing, which aids in creating physical scientific models for hands-on learning, had a mean score of 1.7253 and a standard deviation of 0.89556. Although 37.5% of respondents rated it "Moderately Usable," its adoption is still in its infancy. The Internet of Things (IoT), another highly usable technology, achieved a mean score of 3.0400 and a standard deviation of 0.68677. While only 1.5% rated it as "Highly Usable," its potential for real-time data collection and connectivity is evident, with 30.3% finding it "Moderately Usable."

Mobile learning apps, designed for easy access to educational materials, quizzes, and interactive content, recorded a mean score of 1.9200 and a standard deviation of 0.78693. Despite 26.7% marking them as "Somewhat Usable," their broader potential remains underexplored. Lastly, gamification, which incorporates game elements to enhance student engagement, scored a mean of 1.8520 with a standard deviation of 0.80761. Although 29.5% of educators found it "Moderately Usable," its implementation as a motivational tool in science education remains nascent. In conclusion, artificial intelligence and the Internet of Things demonstrate notable usability, setting them apart from other technologies such as augmented reality and 3D printing, which, while promising, require more strategic integration into educational settings to unlock their full potential.

$H0_1$: *There is no significant difference between accessibility and usability of emerging technology among science educators' for teaching senior school students in Kwara State.*

Table 3:
t-test of significant difference between accessibility and usability of emerging technology among science educators' for teaching senior school students in Kwara State.

Experimental Group	Mean	Std. deviation	Std. Error	df.	t (Cal.)	Sig. (2 tailed)	Decision
Accessibility	2.71	0.86	0.01	3374	-0.12	0.90	Not rejected
Usability	2.71	0.88	0.01				

Source: Field Work

The analysis in Table 3 reveals no significant difference between the accessibility and usability of emerging technologies among science educators teaching senior school students in Kwara State. Both variables recorded identical mean scores of 2.71, with standard deviations of 0.86 for accessibility and 0.88 for usability. The t-value of -0.12 and a p-value of 0.90 indicate that the observed difference is statistically insignificant, as the p-value far exceeds the 0.05 threshold for significance. These findings imply that educators view the accessibility and usability of emerging technologies as comparable, reflecting a balance between how easily these tools can be accessed and how effectively they can be used in educational contexts. This suggests that the challenges and benefits related to the

adoption of these technologies are perceived similarly, highlighting the need for strategies that address both aspects simultaneously to enhance their integration into teaching practices.

Conclusion

The analysis highlights that science educators in Kwara State encounter substantial difficulties in both accessing and effectively utilizing emerging technologies in their teaching practices for senior school students. Among the technologies studied, artificial intelligence demonstrated the greatest accessibility, with a mean score of 3.0373, indicating a higher level of integration into teaching methodologies. However, other technologies such as augmented reality, virtual reality, and the Internet of Things revealed limited accessibility, with mean scores falling below 2. This suggests that adoption barriers like inadequate infrastructure, high costs, and insufficient training may be significant challenges. In terms of usability, artificial intelligence and the Internet of Things emerged as the most effective tools, both scoring above 3. These technologies are valued for their potential to support personalized learning and real-time data applications.

Conversely, tools like 3D printing and blockchain technology showed moderate to low usability. This points to their potential remaining largely untapped due to early-stage implementation and a lack of robust integration into classroom settings. The comparison between accessibility and usability yielded no significant differences, as both dimensions recorded identical mean scores of 2.71, with a p-value of 0.90. This indicates that educators face comparable challenges in accessing and utilizing these tools. Addressing these issues will require holistic strategies that improve both dimensions simultaneously. Proposed solutions include professional development initiatives to enhance educators' skills, investments in technological infrastructure to support broader adoption, and awareness programs to promote the educational value of these technologies. Such measures are critical for leveraging emerging technologies to revolutionize science education in Kwara State.

Recommendations

1. Educational authorities should invest in infrastructure, partner with technology providers, and implement subsidized policies to improve access to emerging technologies like augmented reality, virtual reality, and 3D printing in schools;
2. Professional development programs, including workshops and mentoring, should equip educators with the skills to effectively utilize emerging technologies such as blockchain, mobile learning apps, and gamification in classrooms;
3. A dual approach that raises awareness of the benefits of emerging technologies while providing hands-on training and support can bridge gaps in accessibility and usability, ensuring their successful integration into teaching practices.

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