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## The Role of Smart Technologies in the Development of Science Education in the 21<sup>st</sup> century

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### Abstract

*The study investigated the role of smart technologies in the development of science education in the 21<sup>st</sup> century. Based on the objectives of the study, 3 research questions and a hypothesis guided the study. The study was a descriptive survey type with a population consisting of all science education lecturers in the School of Sciences Alvan Ikoku Federal University of Education Owerri, Imo State. Based on the size of the population, the census sample technique was adopted. The instrument for data collection was a researcher made likert 4-point type questionnaire titled "Role of Smart Technologies in Development of Science Education (RSTDSE)". It had reliability coefficient of 0.84 determined using Cronbach's alpha reliability formula. The instrument was administered to the respondents and the data generated were analyzed using mean and standard deviation to answer research questions while, the hypothesis was tested at 0.05 level of significance using t-test statistical tool. The result of the study revealed that smart technologies such as, smart phones, laptops, internet facilities, smart boards, computers, projectors, iPad and PowerPoint were available in the institution for learning. Smart Technologies had high positive impact on the development of science education in the 21<sup>st</sup> century as demonstrated by the lecturers' responses in the institution. Based on the result, it was recommended among others that lecturers should be retrained on the application of emerging technologies in science education such as smart technologies.*

**Keywords:** Smart technologies, Development, Science Education

### Introduction

Science is understood to be the process of learning how to describe and explain natural occurrences through investigation and observation. On the other hand, education is the act of gaining and transmitting knowledge through instruction and study in a structured environment, like a school. All things considered, science education is the process of gaining scientific information or having an impact on society through instruction and learning in a school setting. Udu(2018)noted that, science education has been recognized, the world over, as a prerequisite for scientific and technological development. It provides opportunities for students to acquire relevant functional knowledge and skills that are associated with scientific processes needed for advancement in science and technology. Students are encouraged to learn and apply scientific skills in science classes because they focus a great deal on practical work that enhances theoretical learning and helps students develop a thorough understanding of the course material as well as scientific skills.

The system of imparting or acquiring scientific knowledge before the 21<sup>st</sup> century was solely dependent on the traditional mode through face-to-face learning approach with the teacher being the direct source of information. Wordu and Azery (2021) indicated that, teachers and pupils converse with one another in a small classroom where desks are arranged in rows facing the chalkboard. In a traditional classroom, the teacher offers clear instructions while the students only have access to pens and paper. It calls for a period of time set out for

questions and answers, and it demands students to listen to the teacher in silence. The abilities that students need to find gainful job in today's world are not sufficiently taught in this educational system. Bii (2013) noted that information presented in lectures, which rely on the use of whiteboards or teacher-recommended reading materials, results in passive students in teacher-centered learning. This method is unable to address the difficulties posed by the global economic era in educational processes and fails to provide students with the 21st century skills that are currently in demand. The teaching process continues in the ever-changing world of today to witness a paradigm shift from the traditional mode of teaching and learning to a more active but learner-centered approach capable of addressing learners' 21st-century skill needs (Schleicher, 2012). Technologies are gradually taking over the education sector in the 21<sup>st</sup> century especially at the higher education levels in Nigeria and harnessing the benefits of these technologies in their numbers and types may improve engagement and push up students' performance rates.

The advancement of technologies in the 21<sup>st</sup> century has brought about varieties of pedagogical strategies in science education. The evolution of these technologies has made the study of science and other areas of education very easy and accessible to students. Raj (2017) noted that, with technology application in education sector, there is a major change in the teaching and learning methods, styles, and content across many schools. Haleema, Javaida, Qadri and Suman (2022) reported that, students have an interesting learning experience when technology is incorporated into the classroom, which keeps them interested in the material without becoming sidetracked. Qureshi, Khan, Raza, Imran and Ismail (2021) indicated that, the global digital revolution has started to seep into the field of education. Since technology is quickly changing the way students learn, it is anticipated that it will enhance education by making it more affordable and accessible. The revolution of new technologies in educational contexts has given educators and learners the opportunity to improve their knowledge, skills, and has redirected the standard of education positively. In Blog (2020) it was reported that technology gives students quick access to knowledge, accelerates their learning, and gives them enjoyable opportunities to put what they've learned into practice. It helps students to delve deeper into complex ideas and explore new topics, especially in STEM. Using technology both within and outside of the classroom allows students to acquire the 21st-century technical abilities needed for their future careers. The use of technology in science education enhances the process of teaching and learning. Teachers continue to have a crucial role in imparting knowledge and assisting students in their learning. However, the 21st century learners need to think and solve problems, communicate, collaborate, create and innovate to prepare them for the 21st century workforce (Hendon, & Abdullah, 2016). The advancement of educational technologies in the form of smart technologies has further widened educational pedagogies availing lecturers and students' different avenues of learning.

The term "smart technology" describes the incorporation of communication and computing technologies into other technologies that lacked such features in the past. A technology is considered "smart" when it can interact and collaborate with other networked technologies. This capability also enables remote accessibility or operation from any location, as well as automatic or adaptive functioning. Interactive Technology and Smart Education (2018), described smart technology as an interactive technology that is responsive to educators' pedagogical tactics as well as learners' educational and social needs, providing a more flexible and customized approach to satisfy a range of individual requirements in a timely manner. Dychkivska (2013) defined "smart technologies" as a collection of cutting-edge technical techniques for creating a higher education institution's learning and development environment with the goal of guaranteeing the systemic achievement of

educational objectives and comprehensive mastering of the content of professional training, as well as introduction of appropriate forms, methods, techniques with significant developmental potential into the educational practice.

Singh (2022) believed that the creation of new technologies makes it possible for students to learn more comfortably, effectively, and efficiently. Students use smart devices to access online content via a wireless network and engage in individualized and seamless learning experiences. Stepanyuk, Mironets, Olendr, and Tsidylo, (2022) noted that the use of SMART-technologies is aimed at achieving the following goals in the learning process: S (Self Directed) – providing opportunities for self-determination of what to learn and effective organization of self-learning; M (Motivated) – motivation of active cognitive activity; A (Adaptive) – adapting the methods, place and time for learning for a specific subject who wants to gain educational services; R (Resource Free) – providing free access to educational resources; T (Technology Embedded) – permanent support of the learning process with modern technologies. Innara, Elena, Olga, Tatiana and Nataliya (2019) conceived smart technologies as tools of new global knowledge, which transformed from information standards to innovational approaches to acquisition of professional skills and competences on the basis of systemic vision and constant update of existing knowledge. Computers, computer accessories, cellphones, smartphones, and other communication devices such as projectors, scanners, printers, photocopying and digitizing machines, Microsoft printers, radio-electronic copiers, and others are examples of smart technologies used in education.

In the twenty-first century, smart technologies have the potential to revolutionize teaching and learning by offering beneficial interactive learning experiences. They afford new learning opportunities and provide different learning experiences resulting in high quality learning outcomes among the learners. Budhrani, Ji, and Lim (2018) indicated that smart technologies have given room for smart learning, which offered students new approaches, learning technologies, learning processes and learning strategies to optimize allocation, resources and benefits obtained. Smart technologies can effectively support learning to happen in different situations.

Gender is one factor that determines teachers and students' decisions or opinion on technology usage. Gender refers to the psychological and cultural differences between males and females. This includes attitudes, behaviours, and social roles. Simkus (2023) refers to Gender as the socially constructed roles, expectations, and behaviors that are often ascribed to the different sexes. In relation with usage of information and communication technology (ICT), Unegbu, Ogugua, Nnadimele and Nse (2020) indicated that there is a gender gap when considering use of ICT, and that gender is a major predictor of ICT and attitude. Odual (2019) stated that male teachers make use of ICT in their teaching and learning processes more than their female counterparts.

Above all, the advancement of computing technologies leads smart computing to a new dimension and improves the ways of learning. However, within the confines of this study, much is not been realized by the educators on the roles of smart technologies in science education.

Thus, the goal of this study is to determine the role of smart technology in advancing science teaching in the twenty-first century.

### **Purpose of the Study**

The goal of the current study was to find out how smart technologies may advance science education in the twenty-first century. In particular, the study investigated;

1. The types of smart technologies in the institution
2. The roles of smart technologies in teaching and learning of science education
3. The difference in Gender opinion on the roles of smart technologies in science education

### **Research Questions**

The following research questions quidded the study.

**Research question 1.** What are the types of smart technologies for teaching and learning of science education?

**Research Question 2.** What are the roles of smart technologies in teaching and learning of science education in the 21<sup>st</sup> century?

**Research Question 3.** What is the difference between the opinion of male and female students on the role of smart technologies in the development of science education in the 21<sup>st</sup> century?

### **Hypothesis**

The following hypothesis was formulated to guide the study.

**Ho<sub>1</sub>:** The development of science education in 21<sup>st</sup> century through smart technologies is not gender dependent.

### **Method**

The study employed the descriptive survey research design to investigate the role smart technologies in the development of science education in the 21<sup>st</sup> century. The population of the study consisted of 135 science education experts in the school of science of Alvan Ikoku Federal University of Education Owerri, Imo State. Based on the size of the population, population census sample technique was adopted in carrying out the study and this includes, 65 males and 70 females. The instrument for data collection was a researcher made likert-4points type of questionnaire titled, "Role of Smart Technologies in Development of Science Education (RSTDSE)". The responses ranged from, Strongly Agree (SA), Agree(A), Disagree(D) to Strongly Disagree (SD). The validity of the instrument was determined by 2 experts in science education and an expert in Measurement and Evaluation from the same Institution. Their expert judgement and recommendations were considered in the adjustment of the instrument. The instrument was administered to 25 subjects who were not among the sample for the study but had similar characteristics, the cronbach's alpha reliability formulawas adopted to determine the reliability of the instrument. This gave a reliability coefficient of 0.84 which was adequate for the study. The instrument was administered to the subjects through various department heads. The instruments were administered and retrieved on the spot. the entire exercise lasted for two weeks and all the instruments were retrieved. The data generated were analyzed using mean and standard deviation to answer research questions. Items response means within and above the criterion mean of 2.50 were accepted while below were rejected. The hypotheses were tested at 0.05 level of significance using t-test statistical tool.

## Results

**Research question 1.** What are the types of smart technologies for teaching and learning of science education?

Table 1: Summary of response analysis

S/N	Items	Mean	SD	Decision
1	Smart phones	3.25	1.02	Accept
2	Laptops	2.71	1.32	“
3	Smart classrooms	2.15	1.41	Reject
4	Internet	2.61	1.23	Accept
5	Smart televisions	1.23	1.30	Reject
6	Smartboards	2.53	1.31	Accept
7	Computers	3.51	1.04	“
8	Ipads	2.50	1.55	“
9	Projectors	3.20	1.05	“
10	Smart cameras	2.21	1.53	Reject
11	PowerPoint	2.52	1.61	Accept
<b>Grand mean=2.58</b>				

Table 1 shows that items 1, 2, 4, 6, 7, 8, 9, and 11 were accepted as smart technologies available for instruction in science education as they had mean response greater than the criterion mean. While, items 3, 5, and 10 were not accepted as they had response mean less than the criterion mean which implied that they were not available.

**Research question 2:** What are the roles of smart technologies in teaching and learning of science education in the 21st century?

Table 2: Summary of response analysis

S/N	Item	Mean	SD	Dcsn
<b>Roles of smart technologies in science education</b>				
1	Interactive learning is encouraged by smart technologies	3.41	0.85	Accept
2	Smart technologies enhance Collaborative learning	3.20	0.91	”
3	Smart technologies give access to online learning resources	2.79	1.03	“
4	They encourage development of critical thinking skills	3.04	1.00	“
5	The use of smart technologies break barriers of learning	2.82	1.21	“
6	Smart technologies grantees flexibility in learning	3.71	0.86	“
7	They help to build students interest in science education	2.92	1.24	“
8	Smart technologies increaseteaching and learning productivity	3.06	1.03	“
9	They enhance accessibility to learning	3.34	0.91	“
10	Smart technologies enhance learning experience	2.68	1.05	“
11	Smart technologies enhancelearners’ creative ability	2.73	1.20	“
12	They facilitate personalized learning	2.63	1.16	“
13	Smart technologies enhance research in science education	3.42	1.03	“
14	Smart technologies save time of learning	3.12	1.01	“
15	They allow revisit of learned materials	3.10	0.93	“
16	Students learn better with smart technologies	3.05	1.02	“
17	Smart technologies allow lecturers to teach from any place without difficulty.	2.72	1.05	“
18	Use of smart technologies enhances communication skills	3.15	1.04	“
19	Smart technologies encourage hybrid learning	3.01	0.93	“
20	They enhance students’ assessment in real time.	2.85	1.18	“
Grand Mean = 3.04		SD = 1.03		



Table 2 shows that all the items were accepted as they had response mean greater than the criterion mean. Also, the grand mean of 3.04 is greater than the criterion means with a standard deviation of 1.03.

**Research Question 3:** What is the difference between the opinion of male and female students on the role of smart technologies in the development of science education in the 21st century?

Table 3: Summary of response analysis

Gender	N	Mean	SD	Mean Diff.	df	t-cal	t-0.05	Decision
Males	65	3.02	1.05	0.07	132	0.39	1.65	NS
Females	70	3.10	1.02					

Table 3 shows that male lecturers had response mean of 3.02 with a standard deviation of 1.05 while their female counterparts had response mean of 3.10 with standard deviation of 1.02. These gave a mean difference of 0.07 in favor of the female lecturers.

**H<sub>01</sub>:** The development of science education in 21st century through smart technologies is not gender dependent.

Table 3 shows that t-calculated value of 0.39 is less than the critical value of 1.65 at degree of freedom of 132 and 0.05 level of significance. Based on the result, the null hypothesis is sustained.

## Discussion

The result of the study revealed that, the smart technologies available for science education lectures in higher institutions includes, smart phones, laptops, internet facilities, smart boards, computers, projectors, Ipads and PowerPoint. It also revealed that the following smart technologies, smart classroom. Smart television and smart cameras were not adequately available as proved by the respondent's response mean. This result is in line with the findings of Onyia (2020) which confirmed that, Smart phones, iPad, laptops, tablets, internet and e-library are available in the universities in South-Eastern Nigeria, while phablets, smart board, digital camera, smart tables, projectors and smart classroom are unavailable.

The use of smart technologies spices the teaching and learning science education. Teaching learning takes place at any distance without barriers, the common goals of science Education is achievable through application of smart technologies. Smart technologies support face-to-face learning through innovative approaches and at the same time brings the learning of science education to learners' doorsteps thereby modifying the scientific pedagogies for development of 21<sup>st</sup> century 4Cs, which includes critical thinking, collaboration, communication and creative skills. The study's findings corroborated these claims, as every item pertaining to smart technologies' contributions to the advancement of science education in the twenty-first century was approved because its answer means exceeded the criteria mean. These suggested that 21st-century scientific education would benefit from the advancement of smart technologies. Further statistical analysis indicated that, the opinion of science lecturers on the development of science education in the 21<sup>st</sup> century through smart technologies is not dependent on their gender. The finding is in tandem with Onyia (2020) which showed that, smart technologies have emerged as a practical innovation that can increase students' motivation to participate in lectures, facilitate learning for both lecturers and students, and inspire students to collaborate and exchange ideas during after-class study sessions. The result also supports the work of Haleema et al(2022) which stated that, Technology in education can help students to prepare for lifelong learning. With

the use of these technologies, students can access digital knowledge in accordance with their learning preferences and immerse themselves in a virtual environment.

### Conclusion

The purpose of the study was to ascertain the role of smart technologies in advancing science education in the twenty-first century. The study's findings demonstrated that the proliferation and variety of smart technologies had a favorable impact on the advancement of science education in the twenty-first century. The positive response of science lecturers on the role of smart technologies was not gender dependent.

### Recommendation

Based on the result of the study, the following recommendations were made;

1. The government should make available smart technologies in institutions of higher learning to enable its application in the learning process.
2. Lecturers should be retrained on the application of emerging technologies in science education such as smart technologies.
3. There should be constant electricity in institutions of higher learning to enable lecturers and students make proper application of available smart technologies.

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