



Teachers' Preparedness and Self-Efficacy in Information Communication Technology as Predictors of Virtual Learning Adoption for Science Teaching in Secondary Schools

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Abstract

This study determined the proportion of variance in teachers' virtual learning adoption for science teaching predicted by technology preparedness and self-efficacy. The study was carried out in Nsukka Education Zone, Enugu state. The study was guided by two research questions and two hypotheses. Correlational survey design was adopted. The population of the study comprised of 220 science teachers, with 90 science teachers sampled using multistage sampling procedure. Data was collected using Teachers' Information Technology Preparedness Scale ($\alpha = 0.79$), Teachers' Self-efficacy Questionnaire ($\alpha = 0.792$) and Virtual Learning Adoption Scale ($\alpha = 0.744$). The reliability indices were determined using Cronbach Alpha. Data collected were analysed using linear regression. Results from the study showed that: the proportion of teachers' virtual learning adoption for science teaching that can be predicted by technology preparedness (52.5%) and technology self-efficacy (41.4%) is significant; teachers' gender positively influences the proportion of variance in virtual learning adoption that can be predicted by teacher preparedness. The study recommends that: science teachers should assess their level of technology preparedness and take part in training sessions to improve it; science teachers should regularly practice the use of virtual learning technology in teaching science concepts to improve their information technology self-efficacy.

Key words: Teachers' Preparedness, Self-Efficacy, Information Communication Technology, Virtual Learning Adoption, Science Teaching.

Introduction

The methods and processes of teaching and learning have evolved in recent years, to meet the needs and aspirations of modern societies. The 21st century is characterized by advancements in science and technology. Technology has permeated all facets of education, including the processes of teaching and learning, resources used in teaching, and the methods of assessing learning outcomes (Mikusa, 2015). Nigeria recognizes the need for technology-driven education and highlights it in the Federal Ministry of Education (2019) where it recommends that teachers and trainers use technology to support all learning across the curriculum. Science is the bedrock upon which contemporary technological breakthrough is built (Freeman & Shostak, 2016), and is recognized as a major driver of national development (World Bank, 2019). Carruthers (2017) defines science as both a body of knowledge and the process of acquiring new

knowledge through observation. This study considers science to be a systematic process of studying natural phenomena. In the contemporary Nigeria, greater emphasis is placed on science and technological development (Federal Republic of Nigeria, FRN, 2014). This makes science teaching and learning important in Nigeria educational system.

Science teaching is a complex and multifaceted endeavor that encompasses a variety of pedagogical approaches, instructional strategies, and assessment techniques. Science teaching is the process of imparting scientific knowledge and skills to students, enabling them to understand the natural world and make informed decisions (Abdullahi, 2022). Adeyemi (2019) refers to it as a crucial aspect of education that fosters critical thinking, problem-solving, and innovation skills essential for success in the modern technologically driven world. This study considers science teaching to



be the process of educating students about science in a formal educational setting like a school. In Nigeria, science teaching plays a pivotal role in driving national development by producing a skilled workforce capable of contributing to scientific advancements and economic growth (Ajayi, 2020). However, the effectiveness of science teaching in Nigerian secondary schools is hampered by several challenges, including inadequate teacher training, limited resources, and outdated teaching methodologies (Akinbode, 2021).

In Nigerian secondary schools, science teaching is carried out through the face-to-face method of teaching which involves teachers and students meeting in a physical classroom. The face-to-face method describes a style of teaching where a teacher uses pure verbal techniques to physically present learning materials to students (Klassen, Borko, Araya, & Guerra, 2023). Abah (2020) defined the face-to-face method as a teaching approach which involves direct instruction by the teacher whose primary role is to pass knowledge to students and conduct testing and assessment. This study considers the face-to-face method to be any teaching method which involved physical interaction between the teacher and the learner(s), where the teacher actively transmits information to the learners, who act as passive receivers in the exchange. Other terms used to refer to the 'conventional method' include: traditional method, face-to-face method, chalk-talk method, among others. This study however uses the term face-to-face method to refer to the conventional method as it clearly contrasts with the virtual form of education which is the crux of the study. This method of teaching is considered obsolete because it renders students passive in science classrooms and does not make for effective science teaching and learning (Blaze, 2017). Enhancing science teaching in Nigerian secondary schools is imperative to equip students with the necessary scientific literacy to thrive in the 21st century and one of the best ways to achieve this is through the integration of technology into the teaching and learning of science to create a departure from the face-to-face method. This integration has yielded an alternative method of science teaching known as virtual learning.

Virtual learning represents a learning approach that does not require students and teachers to meet in a physical setting. "According to Racheva (2017), virtual learning is a process of presenting learning experience through computers and/or the internet both outside and inside the facilities of the educational organization. VanBeek (2011) also defined virtual learning as a form

of learning which uses computer software, the internet or both to deliver instruction to students. Kotobee (2022) refers to virtual learning as the process of using technology to deliver educational material. This study considers virtual learning to a form of teaching and learning where students are taught by instructors/teachers through online learning environments, either via audio or video. This form of learning can take place either in a self-paced (asynchronous) environment or in a real-life (synchronous) environment."

Virtual learning is a new way of learning. It is made popular by the advancement in technology and the need to cope with technology (Meyer, 2021). With almost every students in contemporary times possessing a personal computer and spending most of their time online, virtual learning has become many people's favourite way of schooling. In Nigeria however, this reality has not been achieved because the processes of teaching and learning across all levels (pre-primary to tertiary) is still based on the traditional face-to-face methods, which takes place in the classroom. The outbreak of the Coronavirus (COVID-19) in 2020 necessitated a paradigm shift in teaching and learning all over the world (United Nations, 2020; Kessel, Baronavski, Scheller & Smith, 2021), creating a change in the methods of delivering educational contents to students from the face-to-face classroom teaching to virtual mode of teaching. This situation challenged the education system across the world and forced educators to shift to virtual mode of teaching (VanBeek, 2011).

The suspension of academic activities caused by COVID-19 highlighted the necessity for learning platforms that extend beyond physical classrooms. Many educational institutions, initially hesitant to abandon traditional teaching methods, were compelled to fully transition to online teaching and learning. With social distancing in place, some schools in Nigeria turned to platforms like radio, Telegram, Skype, WhatsApp, and Zoom to deliver educational content. These virtual tools offered a critical alternative for science instruction. The process of incorporating these technologies into science teaching and learning is referred to as virtual learning adoption (VLA). This approach is essential in contemporary educational practices. As noted by Adedoyin and Adeyemi (2023), VLA describes the process by which science educators adopt and integrate virtual learning tools and strategies into their teaching methodologies." The adoption of VLA can manifest in various forms, ranging from simple applications to more comprehensive integrations



(Klassen, Borko, Araya & Guerra 2023). VLA can be used to supplement traditional face-to-face instruction, providing additional resources and activities (Osunmade, Adeoye & Laverty, 2022).

Despite the importance of virtual learning, the empirical evidence demonstrate that several factors impact the adoption of virtual learning. Jimmy (2021) highlights that in academic settings, perceived usefulness of a virtual learning technology has been the predominant driver of technology adoption. Studies (Odegbesan, Ayo, Oni, Adeoba, Okezie, Udenwagu, 2019; Egbokhare & Iyawe, 2012; Codreanu, Michel, Bobillier-Chaumon and Vigneau, 2011) report a shortage of requisite knowledge to effectively adopt virtual learning and the level of virtual learning adoption in the Nigerian educational system is generally low (Oluniyi & Apena, 2016). The studies have exhaustively demonstrated the factors which impact virtual learning adoption but these studies have not been carried out in Nsukka Education zone using secondary school science teachers.

Because the individual is at the center of VLA, this study is interested in studying two individual factors related to virtual learning adoption in science teaching. These factors are teachers' preparedness and information technology self-efficacy. Preparedness is a concept constructed to explain why certain associations are learned and adopted more readily than others (Almakani & Williams, 2012). In the context of this study, preparedness is a term used to determine how 'ready' an individual is to use a technology. Teachers' preparedness for virtual learning adoption can be influenced by several factors, including information technology self-efficacy (Adedoyin & Adeyemi, 2023). Information technology preparedness is important because it equips the teacher with requisite knowledge to identify appropriate technologies for use in the classroom (Hero, 2020), equip the teacher with the skill to successfully utilize it and troubleshoot potential issues arising from its use (Singh & Chan, 2014), and provide a general positive attitude towards the adoption of information technology. Several studies (Iderima & Agwu, 2020; Hero, 2020; Ogan-Bekiroglu & Karabuz, 2017; Kiilu, Nyerere & Ogeta, 2016) have highlighted the preparedness level of teachers to use information technology in teaching, with some reporting it as low (Kiilu, Nyerere & Ogeta, 2016; Hero, 2020; Ogan-Bekiroglu & Karabuz, 2017) and Iderima and Agwu (2020) posited that it is moderate. However, these studies failed to report the relationship between teacher

preparedness and actual adoption of virtual learning in teaching.

Self-efficacy which is thus integral to a person's ability to successfully undertake technology-related tasks like the use of VLTs is referred to as technology self-efficacy. According to Saville and Foster (2021), information technology self-efficacy is the extent to which people believe they can successfully utilize specific technologies, especially in teaching science concepts. Studies (Chen & Chen, 2021; Sanchez-Prieto & Olmos-Gallego, 2023; Hamidian & Mohammadi, 2023) highlight the fact that teachers with positive information technology self-efficacy tend to adopt virtual learning in teaching, enjoy using it, find it easy to use and demonstrate a general positive attitude towards the integration of technology in their classrooms. However, these studies were carried out in Europe and Asia where technology acceptance has advanced over the years. Sub-Saharan countries play catch-up to technologically advanced nations, findings from technology-related studies carried out there cannot be generalized to countries like Nigeria, which still struggles to improve technology acceptance and integration in education. Also, the review of literature reveals that little or no study has been carried out to determine the relationship between information technology self-efficacy and adoption of virtual learning among science teachers in Nsukka education zone. This informed the need for the present study, which upon completion filled this gap. The study therefore determined the nature of the relationship among these variables teacher preparedness, technology self-efficacy and virtual learning adoption.

Research Questions

The following research questions were posed to guide the study:

1. What is the predictive power of teachers' preparedness on virtual learning adoption for science teaching in secondary schools?
2. What is the predictive power of information technology self-efficacy on virtual learning adoption for science teaching in secondary schools?

Hypotheses

The following null hypotheses were formulated and was tested at 0.05 level of significance, to guide the study

- Ho₁: The predictive power of teachers’ preparedness on virtual learning adoption for science teaching in secondary schools is not significant.
- Ho₂: Information technology self-efficacy has no significant predictive power on virtual learning adoption for science teaching in secondary schools.

Method

The study adopted a correlational survey design. A correlational survey is a research design where researchers measure the relationship between two or more variables without manipulating any of them (Creswell & Creswell, 2018). The research design was considered ideal for this study because it determined how teachers’ preparedness and information technology self-efficacy predict virtual learning adoption by science teachers in secondary schools. The study was carried out in Nsukka Education zone of Enugu State. The population of the study comprised all 220 (93 males and 127 females) science teachers in 62 public secondary schools in Nsukka Education zone. This population includes 127 (56 males and 71 females), 48 (20 males and 28 females) and 45 (17 males and 28 females) science teachers from Nsukka, Igbo-Eititi and Uzo-Uwani LGAs respectively. The sample size for the study was 90 (59 males and 31 females) science teachers in Nsukka education zone. This sample size was determined using Taro Yamane formula for computation of sample size. Multistage sampling procedure was used to select the 90 science teachers, consisting of 52, 20 and 18 science teachers from each of the sampled schools in Nsukka, Igbo-Eititi and Uzo-Uwani LGAs respectively, to take part in the study. During stage 1, all three LGAs in the zone were

sampled using purposive sampling technique. This was to ensure that all Science teachers in the zone had equal chance of being part of the sample. During stage 2, simple random sampling technique (balloting with replacement) was used to sample 5 co-educational schools from each of the three LGAs, which yielded a total of 15 schools. This sampling technique was adopted to give all schools in each LGA an equal chance of being part of the sample. In stage 3, simple random sampling technique was then used to draw 52, 20 and 18 science teachers from each of the sampled schools in Nsukka, Igbo-Eititi and Uzo-Uwani LGAs respectively.

Three instruments were used for data collection. These are: Teachers’ Information Technology Preparedness Scale (TITPS), Teachers’ Self-Efficacy Questionnaire (TSeQ) and Virtual Learning Adoption Scale (VLAS). The TITPS is a researcher developed 21-item instrument, with a cronbach alpha reliability index of 0.79. The TSeQ is a 21-item instrument with Cronbach alpha reliability index of 0.792, developed by the researcher to elicit data on respondents’ information technology self-efficacy. The VLAS is a 21-item instrument (with a Cronbach alpha reliability index of 0.742), developed by the researcher to elicit data that was used to determine respondents’ adoption of virtual learning. Face and construct validities were also established for the instruments. Construct validity was established using factor analysis with factorially pure items selected for each item using the benchmark of 0.35 stipulated by Griffith et al (2009). At the end of factor analysis, 21 items each survived for the three instruments from the 26 in the TITPS, 28 in the TSEQ and 27 in the VLAS.

Data was collected using the direct delivery and retrieval method. Coefficient of determination (r^2) in linear regression analysis was used to answer the research questions while regression ANOVA was used to test the hypotheses. All hypotheses were interpreted at 0.05 level of significance.

Results

Table 1: Regression analysis for proportion of variance in teachers’ virtual learning adoption that can be predicted by teachers’ preparedness

Model	N	β (Reg. Weight)	R	r^2	SE
1	90	17.912	0.725	0.525	3.817

The result in Table 1 shows that science teachers’ technology preparedness is a predictor of their virtual learning adoption, with positive regression weight ($\beta = 17.912$; $r = 0.725$). This implies that for

every 1-unit increase in science teachers’ technology preparedness, the outcome variable (virtual learning adoption) will increase by 0.725. The coefficient of determination r^2 is 0.525. This implies that the



proportion of teachers' virtual learning adoption that can be predicted by technology preparedness is 52.5%.

The linear regression model thus is $Y = 17.912 + 3.817x$, where x is teachers' virtual adoption.

Table 2: Regression ANOVA of virtual learning adoption Predicted by teachers' preparedness.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	"Regression"	9660.637	1	9660.637	97.231	.000
	Residual	8743.463	88	99.358		
	Total	18404.100	89			

Result in Table 2 shows that the probability associated with the calculated value of F (97.231) is 0.000. Since the probability value of 0.000 is less than 0.05 level of significance, the null hypothesis is

rejected. Therefore, the predictive power of science teachers' preparedness on virtual learning adoption is significant.

Table 3: Regression analysis for proportion of variance in teachers' virtual learning adoption that can be predicted by information technology self-efficacy

Model	N	β (Reg. Weight)	R	r ²	SE
1	90	12.092	0.644	0.414	5.452

The result in Table 3 shows that teachers' information technology self-efficacy is a predictor of their virtual learning adoption, with positive regression weight ($\beta = 12.092$; $r = 0.644$). This implies that for every 1-unit increase in teachers' information technology self-efficacy, the outcome variable (virtual learning adoption) will increase by 0.644. The

coefficient of determination r² is 0.414. This implies that the proportion of science teachers' virtual learning adoption that can be predicted by information technology self-efficacy is 41.4%. The linear regression model thus is $Y = 12.092 + 5.452x$, where x is science teachers' virtual adoption.

Table 4: Regression ANOVA of virtual learning adoption predicted by teachers' technology self-efficacy.

"Model"		"Sum of Squares"	Df	"Mean Square"	F	"Sig."
1	"Regression"	7621.992	1	7621.992	62.208	.000
	"Residual"	10782.108	88	122.524		
	"Total"	18404.100	89			

Result in Table 4 shows that the probability associated with the calculated value of F (62.208) is 0.000. Since the probability value of 0.000 is less than 0.05 level of significance, the null hypothesis is rejected. Therefore, the predictive power of science teachers' technology self-efficacy on virtual learning adoption is significant.

Discussion of Findings

Finding of this study revealed that the proportion of teachers' virtual learning adoption that can be predicted by technology preparedness (52.5%) is significant. This suggests that teachers who are more prepared and comfortable using technology are significantly more likely to embrace and integrate

virtual learning practices into their classrooms. Teacher preparedness thus can predict adoption of virtual learning technologies in teaching as a teacher who is adequately prepared to use technology/virtual learning tools will be more likely to adopt it in teaching than a teacher who is not technologically prepared. This explains the finding that demonstrated that more than half (52.5%) of teachers' adoption of virtual learning technology in teaching can be predicted by technology preparedness.

This finding validates the theory of reasoned action (Fishbein & Ajzen, 1975), which posits that an individual's decision to engage in a particular behavior is based on the outcomes the individual expects will come as a result of performing the behavior. The



adoption of virtual learning in teaching is a planned and well thought-out action and so any teacher who intends to adopt virtual learning technologies in teaching will adequately prepare for it. This would imply assessing and improving their technology preparedness. By demonstrating that teacher preparedness significantly predicts more than half of science teachers' adoption of virtual technology in teaching. The finding also corroborates that of Hero (2020) who demonstrated that teachers' preparedness significantly correlates with ICT integration practices in teaching. It also agrees with that of Kiilu, Nyerere and Ogeta (2016) who reported that 62.1% of teachers' integration of virtual learning technology in teaching can be predicted by technology preparedness. The finding however disagrees with that of Ngo and Nguyen (2021) who found no significant difference in the adoption of virtual learning practices of technologically prepared and unprepared teachers.

The study showed that the proportion of teachers' virtual learning adoption that can be predicted by technology self-efficacy (41.4%) is significant. The finding shows that technology self-efficacy is an important predictor of virtual learning adoption by science teachers. Technology self-efficacy, which is a teacher's belief in their own ability to effectively utilize technology for teaching, acts as a key predictor of virtual learning technology adoption by science teachers. Teachers with high self-efficacy are more likely to embrace the challenges of virtual learning because they trust their skills to navigate new platforms or software. They are also more willing to experiment, persist through technical setbacks, and seek out the necessary support to succeed. This confidence fuels motivation and encourages them to actively seek virtual learning opportunities, integrating them into their science curriculum to create innovative and engaging learning experiences.

This finding corroborates the tenets of Bandura's (1986) social cognitive theory which argues that self-efficacy emphasizes the critical role of self-efficacy in human cognition, motivation, and behaviour. Social cognitive theory gives prominence to a self-system that enables individuals to exercise a measure of control over their thoughts, feelings, and actions. From the foregoing, irrespective of their level of technology preparedness a science teacher who is confident in his ability to effectively adopt virtual learning technology in teaching, is more likely to do so than one who lacks that confidence. This finding corroborates the findings of Ghaith & Saleh (2022) and Zhao and Zhao (2021), who both reported that computer

self-efficacy significantly predicted adoption and intention to utilize virtual learning technology respectively in teaching. The finding however disagrees with that of Tondeur et al (2022) who found that while self-efficacy positively influenced general ICT integration in classrooms, it did not specifically predict the use of ICT for online learning. This suggests that self-efficacy may be a broader construct influencing various aspects of technology use in teaching, and additional factors specific to online learning environments might play a stronger role in its adoption.

Conclusion

The present study highlights crucial factors influencing the integration of technology in education. The findings reveal significant relationships between teachers' technology preparedness and self-efficacy with their adoption of virtual learning. Specifically, 52.5% of the variation in virtual learning adoption can be predicted by technology preparedness, and 41.4% can be predicted by technology self-efficacy. These results underscore the importance of providing teachers with adequate training and support to enhance their ICT skills and confidence, which in turn can positively impact their willingness to embrace virtual learning tools in their teaching practices. Ultimately, these findings emphasize the need for targeted interventions and ongoing professional development to empower teachers in leveraging technology for enhanced learning experiences in secondary school science classrooms.

Recommendations

From the findings of the study and discussion, the following recommendations were made:

1. Science teachers should assess their level of technology preparedness and take part in training sessions to improve their technology preparedness. These training can be in form of workshops organized by the Ministry of Education to train teachers on computer appreciation skills.
2. School administrators should encourage teachers to utilize virtual learning technologies in teaching science when possible in their schools. This will challenge teachers to improve their preparedness and self-efficacy in using technology in teaching.
3. Beyond preparedness and self-efficacy, school administrators should furnish their schools with facilities (like computers, internet connectivity and electricity) that will facilitate the adoption



of virtual learning technology in science teaching.

4. Science teachers should adopt measures like regularly practicing the use of virtual learning technology in teaching science concepts so as to improve their information technology self-efficacy.

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