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Factors Influencing STM Teachers' Acceptance of Mobile Learning in South-West Nigeria

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Abstract

Science, Technology, and Mathematics (STM) education in Nigeria faces numerous challenges, including declining student performance, reduced enrolment rates, and limited integration of technology into teaching practices. Nevertheless, former investigations have proven the effectiveness of mobile learning (m-learning) in mitigating the difficulties encountered in STM education. Notwithstanding the paybacks accrue to m-learning STM teaching space, its espousal and implementations are still lower than the projected rates. The reception of m-learning is a function of the disposition of its handlers. While many studies focused on students' reception of m-learning, very few studies have examined STM teachers' reception of m-learning with little or no studies conducted in Nigeria. With the Technology Acceptance Model, this study examined the determinants of STM teachers' behavioural intention (BI) to use m-learning. 280 participants were selected through purposive sampling technique from 60 senior secondary schools in south-west Nigeria and this constituted the sample of the study. A quantitative approach within the blueprint of descriptive survey design of a correlational type was implemented and numerical data collected with a valid and reliable questionnaire were analysed at 5% level of significance using multiple regression analysis and Pearson product-moment correlation coefficient. The study outcomes showed that 85.2% of the variance in STM teachers' behavioural intention (BI) to use m-learning was accounted for by the joint of perceived attitude (ATT), perceived ease of use (PEOU), perceived usefulness (PU), perceived resources (PR) and perceived social influence (PSI) with a significant $F_{(5, 274)}= 811.348$. There was a significantly positive and meaningful relationship between the STM teachers' BI and PSI (r=.512, $p<.01$), PR (r=.446, $p<.01$), PEOU (r=.425, $p<.01$), ATT (r=.414, $p<.01$), and PU (r=.502, $p<.01$). PU was the best meaningful predictor of BI to use m-learning among the STM teachers (β = 1.656, t = 18.445, p=.000), followed by ATT (β = 1.246, t = 14.002, p=.000), followed by PR (β =1.112, t = 12.224, p=.000) and followed by PEOU (β = 1.086, t = 10.005, p=.000). PSI was the least predictor of BI to use m-learning among STM teachers (β = .886, t = 8.896, p=.000). The regression equation that satisfied the model is displayed by BI to use m-learning$_{predicted}$=9.62 + 2.564 PR + 3.814 PU + 2.845 ATT + 1.089 PEOU + 1.004 PSI towards m-learning. The present study did not use a mixed-methods approach so future studies could combine quantitative and qualitative data, to gain a more comprehensive understanding of mobile

learning acceptance and its influencing factors. Nevertheless, this study concluded that more seminars and workshops should be conducted for STM teachers to enhance their reception of m-learning for pedagogical transactions in the classrooms in Nigeria.

Keywords: Reception, mobile learning, STM, teachers, Technology Acceptance Model.

INTRODUCTION

The amplified progress in high-tech growth is transmuting our level of awareness, thinking, communication, socialization, work, and transportation. This rapid growth in technology is driven by the Internet of Things (IoT) and aided by robotics, virtual reality, and artificial intelligence. Today, the world is feeling the impact of the fourth industrial revolution (4IR) that started in the early 2000s. The 4IR is expected to boost the value of life of humankind and promote economic growth and development of all nations by increasing the per capita income of every citizen. To function effectively in the 4IR, people need to be equipped with intellectual skills of flexible mindset, creativity, logical thinking and mathematical reasoning, core skills of process and content skills and cross-purposeful skills of social skills, technical skills, thinking skills, and problem-solving skills (Awofala, Olabiyi, Ogunleye, Udeani, & Fatade, 2017; Awofala & Lawal, 2022; Okunuga, Awofala & Osarenren, 2020; Sarkingobir, Egbebi, & Awofala, 2023). These skills are inherent in Science, Technology, and Mathematics (STM) education. It is evident that about 75% of the most sought-after occupations in the world need STM skills and knowledge (Makgato, 2019; Awofala**,** Ojo, Okunuga, Babajide, Olabiyi, & Adenle, 2019). Nevertheless, in Nigeria, students' interest in STM-related subjects is very low and they often show poor performance in these subjects (Awofala & Fatade, 2023; Awofala, 2016; Awofala, Arigbabu & Awofala, 2013). In Nigeria, senior secondary schools' STM education is confronted with numerous difficulties (Awofala & Fatade, 2023) of which poor performance is the most significant (Awofala & Lawani, 2020a). According to Awofala and Lawani (2020b) teachers in Nigeria are fond of using traditional lecture-based instruction which fails to enhance profound all-inclusive STM learning practices. The underachievement in STM courses in Nigeria is a result of continued disconnection between the instructional methods and students' erudition penchants in the teaching space. Inadequate learning and teaching resources, laboratories and equipment to promote efficient STM pedagogical discourse in senior secondary schools contribute to the under-achievement of students (Awofala & Fatade, 2023). Based on these studies, it is concluded that in senior secondary schools in Nigeria, STM teaching and learning is at its low ebb thereby leading to students not attaining the skills required in the 4IR.

LITERATURE REVIEW

Numerous prior investigations have revealed that mobile-learning (m-learning) can ease the difficulties in STM education (Alrajawy et al., 2017; Edumadze, Ditlhokwa, & Demuyakor, 2022; Mahasneh, 2021; AlMarwani, 2021; Camilleri, & Camilleri, 2019; Yıldız, Yıldırım, Akça, Kök, Özer, & Karataş, 2020; Moradi, & Fazeli, 2022). The introduction of 4IR in Nigeria will help to sustain m-learning as internet access will be widened and data bundles made affordable to people. Accordingly, m-learning has a lot of benefits (Edumadze, Ditlhokwa, & Demuyakor, 2022; Mahasneh, 2021; AlMarwani, 2021; Camilleri, & Camilleri, 2019; Yıldız, Yıldırım, Akça, Kök, Özer, & Karataş, 2020; Moradi, & Fazeli, 2022; Al-Emran & Salloum, 2017). First, m-learning transforms a teacher-centred pedagogy to learner-centred thereby stimulating profound full learning experiences for the students. Second, m-learning helps teachers with diverse teaching strategies such as chat, group work, live polling tools, audio recording features, and online discussion forums, which can be adapted to meet students' diverse learning inclinations and penchants. Third, m-learning allows students to envision experiments in science and this can enhance their understanding of science thereby enabling them to have full explanations of scientific concepts at their

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fingertips. Fourth, m-learning makes learning materials ubiquitous as students can learn materials anytime and anywhere. Fifth, m-learning amplifies interaction hours between the students and the teachers, thus reducing time loss. Sixth, m-learning can serve as a cognitive tool to resolve genuine problems and promote reflection and teamwork during learning.

M-learning is described as the utilisation of a mobile device like laptops, iPads, tablets, and smartphones in the learning content of various school subjects (Gómez-Ramirez, Valencia-Arias, & Laura Duque, 2019; Almaiah, Al-lozi, Al-Khasawneh, Shishakly, & Nachouki, 2021; Fagan, 2019). M-learning offers inimitable prospects for combatting the various STM education needs and challenges (Almaiah, Al-lozi, Al-Khasawneh, Shishakly, & Nachouki, 2021; Fagan, 2019). To gain efficiency in STM education, m-learning can be deployed to organize content and make it more engaging thereby inspiring students to spend more time on learning. According to Ajao and Awofala (2024), this is attainable by embedding problem-solving phases and videos in their ambulatory STM books. In addition, instruction can be documented in videos and asynchronously delivered, thereby allowing STM students to view them repetitively until they gain mastery of the content. Despite the huge benefits that accrue to m-learning in STM classrooms, it is evident that the potency of m-learning is utterly ignored, and could be unattainable if the dispositions and affectation of teachers are not considered (Odiakaosa, Dlodlo, & Jere, 2017; Awofala, Lawal, Arigbabu & Fatade, 2022). In essence, there is a huge gap between the usage and accessibility of m-learning digital tools for pedagogical transactions by teachers (Awofala et al., 2021). Students can deploy mobile devices casually to back their learning; yet, this remains informal pending teachers back its integration into classroom engagement (Gómez-Ramirez, Valencia-Arias, & Laura Duque, 2019; Almaiah, Al-lozi, Al-Khasawneh, Shishakly, & Nachouki, 2021; Fagan, 2019). Teachers may simply impact students' reception of m-learning. Therefore, teachers' intention to deploy m-learning is imperative for its fruitful enactment in STM classrooms in Nigeria.

In essence, the acceptance of a novel technology is a function of the users' attitudes (Awofala & Oladipo, 2023; Awofala, Akinoso & Fatade, 2017; Awofala**,** Olabiyi, Awofala, Arigbabu, Fatade, & Udeani, 2019). Arguably, m-learning cannot be enacted and implemented successfully in STM classrooms without STM teachers' attitudes. Consequently, it is important to examine senior secondary school STM teachers' attitudes towards m-learning in Nigeria. Though outside Nigeria, series of investigations have been conducted in higher institutions of learning on the reception of m-learning (Al-dheleai, Baki, Tasir, & Al-rahmi, 2019; Edumadze, Ditlhokwa, & Demuyakor, 2022; Mahasneh, 2021; AlMarwani, 2021; Camilleri, & Camilleri, 2019; Yıldız, Yıldırım, Akça, Kök, Özer, & Karataş, 2020; Moradi, & Fazeli, 2022; Al-Emran & Salloum, 2017; Alasmari & Zhang, 2019), hence its fruitful enactment. Arguably, for m-learning to be positively recognized in senior secondary schools in Nigeria, more teacher-reception studies are required. Very few studies focused on senior secondary school teachers (Nikou & Economides, 2018; Alshmrany & Wilkinson, 2017; Siyam, 2019), and students (Estriegana, Medina & Barchino, 2019; Gómez-Ramirez, Valencia-Arias, & Laura Duque, 2019; Almaiah, Al-lozi, Al-Khasawneh, Shishakly, & Nachouki, 2021; Fagan, 2019) reception of m-learning are outside the shores of Nigeria. Siyam (2019) studied special school teachers' reception of m-learning. The reception of m-learning valuation in 32 European countries was studied by Nikou and Economides (2018). Alshmrany and Wilkinson (2017) examined primary school teachers' reception of m-learning.

Furthermore, studies that investigate m-learning reception in STM, particularly in south-west Nigeria, are scarce. This present study relies on the studies conducted outside the shores of Nigeria. For m-learning to be fruitfully enacted in developing countries like Nigeria, more studies on the reception of m-learning should be carried out, particularly on teachers' reception (Gómez-Ramirez, Valencia-Arias, & Laura Duque, 2019; Almaiah, Al-lozi, Al-Khasawneh, Shishakly, & Nachouki, 2021; Fagan, 2019). Therefore, the present study pursued to investigate the elements that senior secondary school STM teachers consider

vital for the reception of m-learning in South-west Nigeria. Quite a few models have been advanced to elucidate user reception of information systems. For m-learning, the Technology Acceptance Model (TAM) (Gómez-Ramirez, Valencia-Arias, & Laura Duque, 2019; Almaiah, Al-lozi, Al-Khasawneh, Shishakly, & Nachouki, 2021; Fagan, 2019) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Blut, Chong, Loong, & Venkatesh, 2022) are the frequently adopted models. The UTAUT is disparaged for making it difficult to forecast behaviours that are outside the control of an individual. M-learning can be enacted and operators can be coerced to utilize it. Thus, because of this disadvantage, UTAUT was not adopted and the study settled for the TAM. Previous researches have been conducted to comprehend teachers' and students' reception of m-learning (Gómez-Ramirez, Valencia-Arias, & Laura Duque, 2019; Almaiah, Al-lozi, Al-Khasawneh, Shishakly, & Nachouki, 2021; Fagan, 2019; Edumadze, Ditlhokwa, & Demuyakor, 2022; Mahasneh, 2021; AlMarwani, 2021; Camilleri, & Camilleri, 2019; Yıldız, Yıldırım, Akça, Kök, Özer, & Karataş, 2020; Moradi, & Fazeli, 2022; Siyam, 2019; Nikou & Economides, 2019) and the TAM has been widely adopted. Siyam (2019) used the expanded TAM to investigate the elements that teachers of special education high schools consider vital when utilizing m-learning. The study results disclosed that both perceived attitudes (ATT) and perceived usefulness (PU) towards m-learning impacted teachers' behavioural intention (BI) to use m-learning. These outcomes were analogous to the outcomes of Edumadze, Ditlhokwa and Demuyakor (2022), who showed that the teachers' intention to deploy m-learning for instructional purposes was influenced by their ATT and PU.

In the work of Nikou and Economides (2019), both PU and perceived ease of use (PEOU) showed a weighty impact on ATT towards m-learning. Checking the outcomes of Edumadze, Ditlhokwa and Demuyakor (2022), PEOU was found to be significantly influenced by teachers' PU (Siyam 2019). By extending the TAM, Nikou and Economides (2019) added the facilitating conditions and perceived resources (PR) and the study results showed that PR impacts teachers' PEOU. Gómez-Ramirez, Valencia-Arias and Laura Duque (2019) similarly expanded the TAM with the inclusion of perceived social influence (PSI) and the outcomes of the study revealed that PSI influenced teachers' ATT, PEOU, and PU. Presently, in this study, BI is defined as the state of capableness of STM teachers' intention to carry out a specific behaviour (Awofala & Oladipo, 2023; Lin, Hsu, & Chen, 2023; Samad, Iksan, & Khalid, 2019). ATT toward m-learning is defined as senior secondary school STM teachers' global feeling towards the utilisation of m-learning (Awofala & Oladipo, 2023; Mutambara & Bayaga, 2020). PU is defined as the extent to which STM teachers believe that the use of m-learning will improve learners' performance (Awofala & Oladipo, 2023; Mutambara & Bayaga, 2020). PSI is defined as the extent to which STM teachers think that their cycle of influence would believe that they should utilise m-learning for instructional purposes (Lin, Hsu, & Chen, 2023; Samad, Iksan, & Khalid, 2019). PR is defined as STM teachers' belief that the accessibility of resources can assist in the use of m-learning (Mutambara & Bayaga, 2020). PEOU is described as the extent to which STM teachers believe that adopting m-learning for instructional purposes would be effort-free (Lin, Hsu, & Chen, 2023; Samad, Iksan, & Khalid, 2019).

RESEARCH QUESTIONS

The present study is guided by the following research questions:

RQ1. What is the relationship between ATT, PR, PSI, PU, PEOU and BI to deploy and utilize m-learning for instructional purposes among senior secondary school STM teachers in south-west Nigeria?

RQ2. What is the predictive influence of ATT, PR, PSI, PU, and PEOU on senior secondary school STM teachers' BI to use m-learning in southwest Nigeria?

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METHODS

RESEARCH DESIGN

This study is guided by a numerical method that assembles biodata and view-dependent data by utilizing a survey. A descriptive survey of a correlational type was adopted for the study because interest was in showing relationships between the variables of the study (Awofala et al., 2022). Generally, a survey tool is regarded as the most suitable for testing models and survey designs are cost-effective and fast.

PARTICIPANTS

The respondents for this study included public senior secondary school STM teachers in the south-west geo-political zone of Nigeria. Six states make up south-west Nigeria and they include Lagos, Ekiti, Ogun, Ondo, Oyo, and Osun. Ten schools each were randomly selected from the capital of each state in southwest Nigeria to make a total of 60 schools. A purposive sampling procedure was deployed in choosing five STM teachers from each of the 60 schools to make a total sample of 300 respondents. 300 questionnaires were given out to the STM teachers and only 280 respondents returned the filled questionnaire. Of the 280 STM teachers who filled out the questionnaire, 235 (83.93%) were male while the remaining 45 (16.07%) were females. Their ages ranged between 22 and 64 years. 54 (19.28%) STM teachers were less than 30 years of age, 78 (27.86%) were between 30 and 39, 80 (28.57%) were between 40 and 49, and 68 (24.29%) were 50 years and above. It is recommended that a small sample size of 10 times higher than the number of indicators of the potential construct with the greatest items (Hair, Hult, Ringle, & Sarstedt, 2017) should be considered in the formation of a sample for the study. This current investigation has perceived usefulness (with five items) as the factor with the highest number of items, thereby giving the least sample of 50 respondents. Presently, the investigation sample is far higher than the endorsed least sample of 50 respondents.

INSTRUMENT

The study utilised a questionnaire for data collection. The questionnaire had two major parts. Part one contained information regarding the senior secondary school STM teachers' biodata such as age and gender. The second part consisted of the scales assessing the latent variables of the model with questionnaire items adapted from previous studies (Lin, Hsu, & Chen, 2023; Sivo, Ku, & Acharya, 2018; Alrajawy et al., 2018) and revised in conformity to the study objectives. All the items that measured STM teachers' PU, PEOU, BI, ATT, PR, and PSI were culled from previous research works (Alrajawy et al, 2018; Sivo et al, 2018; Lin, Hsu, & Chen, 2023). The second part of the questionnaire contained the six latent variables, with a total of 25 items and all items were assessed on a 5-point Likert-type scale with 5 commensurate to "strongly agree" and 1 to "strongly disagree. The items of the six latent variables were assessed for reliability values. Table 1 below shows that the Cronbach Alpha (CA) for all the factors were between 0.87 and 0.95 and the internal reliability was accepted. The Composite Reliability (CR) ranged from 0.90 to 0.96 and this was considered adequate for the study. The test of convergent validity was assessed using the Average Variance Extracted (AVE) (Hair et al., 2017) which evaluates the extent to which a measure of the identical construct relates with each other.

Table 1: CA, CR and AVE

Construct	No of items	CA	CR	AVE
BI	4	0.95	0.96	0.90
PEOU	4	0.89	0.90	0.84
PU	5	0.90	0.92	0.85
ATT	4	0.93	0.94	0.87
PR	4	0.89	0.92	0.88
PSI	4	0.87	0.90	0.87

PROCEDURE FOR DATA COLLECTION

The authors sought the permission of each school to carry out the study and informed consent forms given to the STM teachers to fill out before the administration of the questionnaires. Of the 300 questionnaires handed down to the STM teachers, 280 (93.3%) valid questionnaires were returned. Five research assistants were recruited in each state to make a total of 30 research assistants for the resolution and implementation of the study. The research assistants helped in the data collection process which lasted for two weeks. The administration of the questionnaire on the participants was done concurrently in each state capital. Anonymity and confidentiality of all the participants were ensured as only participants who volunteered themselves and were not under compulsion were administered the questionnaire.

DATA ANALYSIS

Before the collected data were analysed, they were screened for missing data and the assumption of regression and correlation analyses were checked. No missing data were recorded through the descriptive analysis. Boxplot was used to detect univariate outliers; scatterplot was used to detect bivariate outliers while mahanalobis distance was carried out for the detection of multivariate outliers (Hair et al., 2017; Leys, Delacre, Mora, Lakens, & Ley, 2019). No outliers were detected in the study. The normality of the data was checked through the computation of skewness and kurtosis values for the study constructs and the values were within the satisfactory range. Thus, the data were normally distributed, therefore the parametric statistics of multiple regression analysis and Pearson product-moment correlation coefficient were used. A 5% level of significance was used for all statistical tests. The variance inflation factor was computed for all the predictor variables to determine whether they have strong associations with other variables and each of the values was less than 10 indicating that the variables had no multicollinearity (Nakarmi, 2024). The tolerance values because they are connected with IVF values were also computed and each was greater than 0.2 indicating good tolerance values (Nakarmi, 2024).

RESULTS

RQ1: What is the relationship between PU, ATT, PEOU, PR, PSI and BI to use m-learning among senior secondary school STM teachers in southwest Nigeria?

Table 2 revealed the correlations among BI, PSI, PR, PEOU, ATT, and PU to adopt and utilize m-learning for pedagogical transactions in the classroom. There was a significantly positive and meaningful relationship between the STM teachers' BI and PSI (r=.512, $p<.01$), PR (r=.446, $p<.01$), PEOU (r=.425, $p<.01$), ATT (r=.414, $p<.01$), and PU (r=.502, $p<.01$). Additionally, there were weighty positive relationships between PU and ATT (r=.508, $p<.01$), PEOU (r=.627, $p<.01$), PR (r=.406, $p<.01$), and PSI (r=.425, $p<.01$). More so, there were statistically weighty correlations between ATT and PEOU (r=.542, $p<.01$), PR (r=.564, $p<.01$), and PSI (r=.346, $p<.01$). In addition, there were significant associations amid

PEOU and PR (*r*=.426, *p<.01*) and PSI (*r*=.358, *p<.01*). Additionally, there was a significant relationship between PR and PSI (*r*=.434, *p<.01*).

Table 2: Mean, standard deviation, and correlations matrix for the association between PU, ATT, PEOU, PR, PSI and BI to use m-learning

	1	2	3	4	5	6
1. BI	1					
2. PU	.502*	1				
3. ATT	.414*	.508*	1			
4. PEOU	.425*	.627*	.542*	1		
5. PR .	446*	.406*	.564*	.426*	1	
6. PSI	.512*	.425*	.346*	.358*	.434*	1
Mean	16.01	22.02	16.46	17.05	16.58	16.85
SD	4.15	4.72	4.25	4.86	4.68	4.76
N	280	280	280	280	280	280

*Values of correlation are significant at a 1% level (2-tailed).

RQ2: What is the predictive influence of ATT, PR, PSI, PU, and PEOU on senior secondary school STM teachers' BI to use m-learning in southwest Nigeria?

Table 3 displayed the combined and marginal predictive influence of ATT, PR, PSI, PU, and PEOU on STM teachers' BI to use m-learning for pedagogical transactions. As contained in the table, the R-value of 0.923 simply showed a high association. Hence, 85.2% which reveals the R^2-value explained the joint impact of the predictors (ATT, PR, PSI, PU, and PEOU) to the explanation of variance in STM teachers' BI to engage and use m-learning for pedagogical discourse in the classroom. The proportionate input is significant with an F value of 811.348 at 5% level of significance. This showed that the data fitted the regression equation.

Table 3: Model summary of the multiple regression analysis of ATT, PR, PSI, PU, PEOU and BI

Model summary					
Multiple R^2 (Adjusted)= .850; Multiple R^2= .852; Multiple R= .923;					
df2=274; df1=5; *p*<.001; *F*=811.348; Standard Error Estimate= 3.108;					
Model	**B**	**Std Error**	**Beta**	t	Sig
Constant	9.62	.401		12.954	.000
Perceived resources	2.564	0.87	1.112	12.224	.000
Perceived usefulness	3.814	.097	1.656	18.445	.000
Perceived attitudes	2.845	.145	1.246	14.002	.000
Perceived ease of use	1.089	.088	1.086	10.005	.000
Perceived social inf.	1.004	.078	.886	8.896	.000

Table 3 showed the marginal contribution that PU was the best meaningful predictor of BI to use m-learning among the STM teachers (β = 1.656, *t* = 18.445, *p*=.000), followed by ATT (β = 1.246, *t* = 14.002, *p*=.000), followed by PR (β =1.112, *t* = 12.224, *p*=.000) and followed by PEOU (β = 1.086, *t* = 10.005, *p*=.000). PSI was the least predictor of BI to use m-learning among STM teachers (β = .886, *t* = 8.896, *p*=.000). The regression equation that satisfied the model is displayed by BI to use m-learning$_{predicted}$=9.62 + 2.564 PR + 3.814 PU + 2.845 ATT + 1.089 PEOU + 1.004 PSI towards m-learning.

DISCUSSION

The present study has shown the need to focus more attention on the determinants of BI to deploy and utilize m-learning for instructional purposes among STM teachers in Nigeria. The present study revealed that perceived social influence (PSI), perceived ease of use (PEOU), perceived attitudes (ATT), perceived usefulness (PU), and perceived resources (PR) showed a significant relationship with behavioural

intention (BI) to use m-learning. This is because STM teachers who feel that they have the necessary resources like time, support and infrastructure could show good intentions to use m-learning. In addition, STM teachers who believe that m-learning would improve their learning outcomes in order to achieve their learning goals would be happy to use m-learning for instructional purposes. A negative attitude in the form of scepticism or a positive attitude in the form of enthusiasm could influence STM teachers' intention to use m-learning. STM teachers who felt that m-learning is easy to use and navigate, reducing anxiety and increasing confidence would show positive intention to use m-learning. STM teachers who are influenced by peers, instructors and organisations could be encouraged or discouraged to use m-learning for instructional purposes depending on the nature of the influence. These factors showed an association with STM teachers' BI to utilise m-learning because they are hinged on the Technology Acceptance Model (TAM), which is a well-known theoretical framework for predicting STM teachers' acceptance and adoption of new technologies (Awofala & Oladipo, 2023; Edumadze, Ditlhokwa, & Demuyakor, 2022; Mahasneh, 2021; AlMarwani, 2021; Camilleri, & Camilleri, 2019; Yıldız, Yıldırım, Akça, Kök, Özer, & Karataş, 2020; Moradi, & Fazeli, 2022), including m-learning.

The study showed that ATT, PR, PSI, PU, and PEOU were significant predictors of STM teachers' BI to adopt and utilize m-learning in the Nigerian context. These constructs contributed more than 85% of the change in STM teachers' BI to adopt and utilize m-learning for attaining instructional objectives in Nigerian classrooms. The study showcased the effectiveness of PU in significantly predicting STM teachers' BI to adopt and utilize m-learning for instructional purposes. This result agreed with the finding of Siyam (2019) but did not corroborate the results of Mutambara and Bayaga (2020) who found that ATT was the best predictor of BI among STM teachers in South Africa. STM teachers' ATT towards m-learning have a way of influencing the mode they see and adopt m-learning for teaching purposes. STM teachers' ATT toward m-learning can govern their usage of m-learning for instructional purposes. Showing meaningful and constructive ATT towards m-learning can enhance STM teachers' BI to use m-learning for educational purposes as seen in the present study. No teacher is capable of gaining proficiency in BI to deploy and utilize m-learning without showing an enhanced ATT towards m-learning adoption and integration.

One other determinant of STM teachers' BI to use m-learning in the present study was PEOU. In this study, the STM teachers perceived m-learning as easy to learn, flexible, easy to comprehend, easy to adopt and easy to apply in the pedagogical discourse. These indicators of PEOU work well to promote STM teachers' BI to deploy and utilize m-learning for educational purposes in Nigeria. The extent to which the STM teachers perceived the easiness to utilise the m-learning had impact on their BI to deploy and utilize it in the classroom during the pedagogical discourse. PR is defined as STM teachers' trust that the accessibility of resources can simplify the utilization of m-learning as a way of enhancing the BI of the STM teachers. Important resources required for the enhancement of m-learning include admittance to a wireless network, accessibility to portable devices, computer methodological support, and availability of data packages. The successful enactment of m-learning in the classroom requires that the STM teachers have portable technology and this is ditto for the students.

The present study revealed that PSI is a strong factor in STM teachers' BI to deploy and utilize m-learning in the classroom. The perception of others about STM teachers' capability of using m-learning has a way of predicting their BI to use m-learning. This perception could emanate from students, colleagues, parents of students and education officials (Mutambara & Bayaga, 2020) and thus influences the intention of STM teachers to adopt and utilize m-learning (Dahri et al., 2023; Samad, Iksan, & Khalid, 2019; Moradi, & Fazeli, 2022).

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CONCLUSION

The present study has shown that there were five indicators of STM teachers' BI to deploy and utilize m-learning in south-west Nigeria and PU was the greatest forecaster of STM teachers' BI to deploy and utilize m-learning in the classroom. This was followed by ATT and the least determinant of BI to adopt and utilize m-learning for instructional purposes was PSI. PR was a better forecaster of BI to deploy and utilize m-learning than PEOU while ATT was a better predictor of BI to deploy and utilize m-learning than PR. Presently, the model used in this study accounted for 85.2% of the variance in STM teachers' BI to adopt and utilize m-learning for instructional transactions in southwest Nigeria. The quantitative power of the predictors of senior secondary school STM teachers' BI to use m-learning for instructional purposes in the classroom is given as follows: PU >ATT >PR >PEOU >PSI. This study is significant to the country, institutions, community, and sample in various ways. Broadly, the study highlights the importance of considering local factors and contexts in implementing mobile learning initiatives, offering implications for educational systems in similar contexts, particularly in developing countries. It also contributes to the global body of knowledge on mobile learning and teacher acceptance. This study could help to address the digital divide and improve access to quality education in Nigeria, as it provides evidence-based insights for policymakers to develop strategies promoting mobile learning in STM education nationwide. The study could contribute to the national agenda for education reform and digital transformation. This study could encourage institutions to invest in infrastructure and resources supporting mobile learning. It also offers recommendations for schools and educational institutions to develop effective mobile learning strategies. For the community of practice, this study highlights the need for professional development and support to enhance teachers' capacity for mobile learning. It could also help to inform educators and policymakers about the potential benefits and challenges of implementing mobile learning in STM education. For the sample, this study could help to understand the factors influencing their acceptance of mobile learning thereby providing insights into the attitudes and perceptions of STM teachers towards mobile learning.

This study recommends that future studies should be conducted in other regions of the country to explore cultural and contextual differences in mobile learning acceptance. The present study did not use a mixed-methods approach so future studies could combine quantitative and qualitative data, to gain a more comprehensive understanding of mobile learning acceptance and its influencing factors. The TAM could be extended in future studies to incorporate school support and parental involvement. An intervention study could be designed to develop and implement a mobile learning training programme for STM teachers, evaluating its impact on their acceptance and effectiveness. A comparison of mobile learning acceptance and outcomes between STM teachers in urban and rural areas to identify potential disparities can be conducted. Lastly, a longitudinal study to investigate the long-term effects of mobile learning on STM teachers' acceptance and student outcomes can be conducted. The present study used samples from STM teachers in the state capitals which are believed to be developed thereby foreclosing the generalization of this study's findings to rural areas in south-west Nigeria and so the findings should be treated with carefulness. The fruitful execution of m-learning in STM classrooms required that resources should be made available. Advocacy and sensitization programmes should be mounted for all STM teachers to build ATT and strengthen their PEOU and PU in the classroom pedagogical discourse as this will help to increase their PSI to adopt and utilize m-learning. Nevertheless, this study concluded that more seminars and workshops should be conducted for STM teachers to enhance their acceptance of m-learning for pedagogical transactions in the classrooms in Nigeria.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Adeneye O. A. Awofala: Conceptualization, Draft preparation. **Michael A. Adewusi**: Data curation, Writing- Original draft preparation. **Peter A. Betiang:** Data collection, Investigation. **Ruth F. Lawal**: Data Collection, Supervision. **Oladiran S. Olabiyi**: Data Collection, Reviewing, Editing. **Abayomi A. Arigbabu**: Writing- Reviewing and Editing. **Alfred O. Fatade**: Writing- Reviewing and Editing.

DATA AVAILABILITY STATEMENT

Data is available on request from the authors.

REFERENCES

Ajao, E. A., & Awofala, A. O. A. (2024). Developing problem-solving skills in mathematics at primary, secondary, and tertiary levels. *Nigerian Online Journal of Educational Sciences and Technology, 6*(1), 136-152.

Alasmari, T., & Zhang, K. (2019). Mobile learning technology acceptance in Saudi Arabian higher education: An extended framework and a mixed-method study. *Education and Information Technologies, 24*(3), 2127-2144.

Al-dheleai, Y. M., Baki, R., Tasir, Z., & Al-rahmi, W. M. (2019). What hinders the use of ICT among academic staff at Yemen's public universities? *International Journal of Humanities and Innovation, 2*(1), 7-12.

Al-Emran, M., & Salloum, S. A. (2017). Students' attitudes towards the use of mobile technologies in e-evaluation. *International Journal of Interactive Mobile Technologies, 11*(5), 195-202.

Almaiah, M. A., Al-lozi, E. M., Al-Khasawneh, A., Shishakly, R., & Nachouki, M. (2021). Factors affecting students' acceptance of mobile learning application in higher education during COVID-19 using ANN-SEM modelling technique. *Electronics, 10*, 3121. https://doi.org/10.3390/electronics10243121

AlMarwani, M. (2021). Acceptance and use of mobile technologies in learning and teaching of EFL: An economic perspective. *The EuroCALL Review, 28*(2), 39-49. https://doi.org/10.4995/eurocall.2020.12388

Alrajawy, I., Daud, N. M., Isaac, O., & Mutahar, A. M. (2017). Examine factors influencing the intention to use mobile learning in Yemen public universities. *Asian Journal of Information Technology, 16*(2), 287-297.

Alrajawy, I., Isaac, O., Ghosh, A., Nusari, M., Al-Shibami, A. H., & Ameen, A. (2018). Determinants of student's intention to use mobile learning in Yemeni public universities: Extending the technology acceptance model with anxiety. *International Journal of Management and Human Science, 2*.

Alshmrany, S., & Wilkinson, B. (2017). Factors influencing the adoption of ICT by teachers in primary schools in Saudi Arabia. *Education (Mohe), 27*, 143-156.

Awofala, A. O. A., Olafare, F. O., Awofala, A. A., Ojo, O. T., Fatade, A. O., Arigbabu, A. A., & Udeani, U. N. (2021). Prevalence of COVID-19 in Nigeria: Doorway for digital learning of mathematics amid senior secondary science and mathematics students. *International Journal of Innovative Technology Integration in Education, 5*(1), 9-16.

Awofala, A. O. A., & Oladipo, A. J. (2023). A simulation study of preservice STM teachers' technostress as related to supposed utility, attitudes towards portable technology and continuance intents to use portable technology. *Digital Education Review, 44*, 23-29.

Awofala, A. O. A., & Fatade, A. O. (2023). Nigerian students' poor performance in mathematics: Who do we blame? *Nigerian Online Journal of Educational Sciences and Technology, 5*(1), 80-91.

Awofala, A. O. A., & Lawal, R. F. (2022). The relationship between critical thinking skills and quantitative reasoning among junior secondary school students in Nigeria. *Jurnal Pendidikan Matematika (Kudus), 5*(1), 1-16.

Awofala, A. O. A., & Lawani, A. O. (2020a). Examining the efficacy of co-operative learning strategy on undergraduate students' achievement in mathematics. *International Journal of Pedagogy and Teacher Education, 4*(1), 59-82.

Awofala, A. O. A., & Lawani, A. O. (2020b). Increasing mathematics achievement of senior secondary school students through differentiated instruction. *Journal of Educational Sciences, 4*(1), 1-19.

Awofala, A. O. A., Akinoso, S. O., & Fatade, A. O. (2017). Attitudes towards computer and computer self-efficacy as predictors of preservice mathematics teachers' computer anxiety. *Acta Didactica Napocensia, 10*(3), 91-108.

Awofala, A. O. A., Arigbabu, A. A., & Awofala, A. A. (2013). Effects of framing and team-assisted individualized instructional strategies on senior secondary school students' attitudes toward mathematics. *Acta Didactica Napocensia, 6*(1), 1-22.

Awofala, A. O. A., Ojo, O. T., Okunuga, R. O., Babajide, V. F. T., Olabiyi, O. S., & Adenle, S. O. (2019). Investigating perception of the 21st century skills among Nigerian pre-service science, technology and mathematics teachers. *International Online Journal of Educational Sciences, 11*(5), 1-12.

Awofala, A. O. A., Olabiyi, O. S., Awofala, A. A., Arigbabu, A. A., Fatade, A. O., & Udeani, U. N. (2019). Attitudes toward computer, computer anxiety and gender as determinants of pre-service science, technology, and mathematics teachers' computer self-efficacy. *Digital Education Review, 36*, 51-67.

Awofala, A. O. A., Olabiyi, O. S., Ogunleye, A., Udeani, U. N., & Fatade, A. O. (2017). School administrators' perceptions of the employability of preservice science, technology, and mathematics teachers through teaching practice in Nigeria. *International Journal of Research in Education and Science, 3*(1), 42-55.

Awofala, A. O., Lawal, R. F., Arigbabu, A. A., & Fatade, A. O. (2022). Mathematics productive disposition as a correlate of senior secondary school students' achievement in mathematics in Nigeria. *International Journal of Mathematical Education in Science and Technology, 53*(6), 1326-1342.

Blut, M., Chong, A. Y., Loong, T. Z., & Venkatesh, V. (2022). Meta-analysis of the unified theory of acceptance and use of technology (UTAUT): Challenging its validity and charting a research agenda in the red ocean. *Journal of the Association for Information Systems, 23*(1), 13-95. https://doi.org/10.17705/1jais.00719

Camilleri, M. A., & Camilleri, A. C. (2019). The acceptance and use of mobile learning applications in higher education. In Pfennig, A. & Chen, K. C. (Eds.), *3rd International Conference on Education and eLearning (ICEEL2019)*, Barcelona, Spain.

Dahri, N. A., Al-Rahmi, W. M., Almogren, A. S., Yahaya, N., Vighio, M. S., Al-maatuok, Q., Al-Rahmi, A. M., & Al-Adwan, A. S. (2023). Acceptance of mobile learning technology by teachers: Influencing mobile self-efficacy and 21st-century skills-based training. *Sustainability, 15*, 8514. https://doi.org/10.3390/su15118514

Edumadze, J., Ditlhokwa, G., & Demuyakor, J. (2022). Students' acceptance and perceptions of perceived usefulness of mobile learning devices in higher educational institutions. *Online Journal of Communication and Media Technologies, 12*(2), e202209. https://doi.org/10.30935/ojcmt/11539

Estriegana, R., Medina, J. A., & Barchino, R. P. (2019). Student acceptance of virtual laboratory and practical work: An extension of the technology acceptance model. *Computers & Education, 135*, 1-14.

Fagan, M. H. (2019). Factors influencing student acceptance of mobile learning in higher education. *Computers in the Schools, 36*(2), 105-121. https://doi.org/10.1080/07380569.2019.1603051

Gómez-Ramirez, I., Valencia-Arias, A., & Laura Duque, L. (2019). Approach to m-learning acceptance among university students: An integrated model of TPB and TAM. *International Review of Research in Open and Distributed Learning, 20*(3), 141-164.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage Publications.

Leys, C., Delacre, M., Mora, Y. L., Lakens, D., & Ley, C. (2019). How to classify, detect, and manage univariate and multivariate outliers. With emphasis on pre-registration. *International Review of Social Psychology, 32*(1), 1–10. https://doi.org/10.5334/irsp.289

Lin, E. Y.-C., Hsu, H.-T., & Chen, K. T.-C. (2023). Factors that influence students' acceptance of mobile learning for EFL in higher education. *EURASIA Journal of Mathematics, Science and Technology Education, 19*(6), em2279. https://doi.org/10.29333/ejmste/13219

Mahasneh, O. (2021). Factors that affect university college students' acceptance and use of mobile learning (ML). *International Journal of Instruction, 14*(3), 861-872. https://doi.org/10.29333/iji.2021.14350a

Makgato, M. (2019). STEM for sustainable skills for the fourth industrial revolution: Snapshot at some TVET colleges in South Africa. In *Theorizing STEM education in the 21st century*. IntechOpen.

Moradi, R., & Fazeli, M. (2022). Identifying effective factors on acceptance and establishment of mobile learning in virtual training center for academics. *Interdisciplinary Journal of Virtual Learning in Medical Sciences, 13*(3), 190-201. https://doi.org/10.30476/IJVLMS.2022.94924.1147

Mutambara, D., & Bayaga, A. (2020). Predicting rural STEM teachers' acceptance of mobile learning in the fourth industrial revolution. *Journal of Construction Project Management and Innovation, 10*(2), 14-29.

Nakarmi, S. S. (2024). Multi-collinearity in research and the way forward. *Kaladarpan, 4*(1), 85-91.

Nikou, S. A., & Economides, A. A. (2018). Mobile-based micro-learning and assessment: Impact on learning performance and motivation of high school students. *Journal of Computer Assisted Learning, 34*(3), 269-278.

Odiakaosa, O. J., Dlodlo, N., & Jere, N. (2017). Teacher and learner perceptions on mobile learning technology: A case of Namibian high schools from the Hardap region. *Higher Educator-An International Journal, 1*(1), 13-41.

Okunuga, R. O., Awofala, A. O. A., & Osarenren, U. (2020). Critical thinking acquisition of senior secondary school science students in Lagos State, Nigeria: A predictor of academic achievement. *Journal of Curriculum and Instruction, 13*(1), 44-56.

Samad, M. R. A., Iksan, Z. H., & Khalid, F. (2019). Acceptance and readiness to use m-learning among primary school science teachers. *Creative Education, 10*, 3003-3011. https://doi.org/10.4236/ce.2019.1012224

Sarkingobir, Y., Egbebi, L. F., & Awofala, A. O. A. (2023). Bibliometric analysis of the thinking styles in math and its implication on science learning. *International Journal of Essential Competencies in Education, 2*(1), 75-87.

Sivo, S. A., Ku, C. H., & Acharya, P. (2018). Understanding how university student perceptions of resources affect technology acceptance in online learning courses. *Australasian Journal of Educational Technology, 34*(4).

Siyam, N. (2019). Factors impacting special education teachers' acceptance and actual use of technology. *Education and Information Technologies, 24*(3), 2035-2057.

Yıldız, G., Yıldırım, A., Akça, B. A., Kök, A., Özer, A., & Karataş, S. (2020). Research trends in mobile learning. *International Review of Research in Open and Distributed Learning, 21*(3), 175-96.