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Adoption of artificial intelligence in science teaching: From the vantage point of the African science teachers

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Abstract

This study investigated the factors influencing science teachers' 'Artificial Intelligence' (AI) utilization by using the 'Technology Acceptance Model' (TAM). The factors investigated alongside TAM variables were teachers' data like; age, sex, and residence type. TAM items that were correlated in this study included; self-esteem, stress and anxiousness, ease of utilization, behavioural intention, attitude towards AI usage, and expected benefits. The population of this study comprised all science teachers (170) in the Calabar Education Zone of Cross River State, Nigeria. The sample was made up of 79 science teachers comprising (58.22%) 46 females and (41.77%) 33 males. The descriptive and analytical research design was used in this study. A questionnaire named ' Approval of Artificial Intelligence: The Teachers' Eye' Questionnaire (AAITEQ) was used for the study. This study raised 3 research questions. The reliability for AAITEQ was from 0.72 to 0.81 using Cronbach's alpha. Findings indicated that the approval for the utilization of AI was high with an overall mean score of 3.00. The highest predicting value for behaviour intent using TAM variables was the ease of usage r = .789. Science teachers' sex (t, 77 = 1.988; $p = .060$, ($p > .05$), age F (2, 76) = .547; $p = .581$ ($p > .05$) and teachers' residence location (t, .77 = .533; $p = -.062$ ($p > .05$) did not influence the behaviour of science teachers' intention of the utilization of AI. It was recommended that both in-service and pre-service teachers be trained on the utilization of AI.

Keywords: Adoption, Artificial intelligence, Science teachers, Self-esteem, Behavioural intention, Age

Introduction

Artificial intelligence in education

In the twenty-first century, Artificial Intelligence (AI) development has advanced at an unimaginable rate. In today's world, AI has access to every facet of Man's world. This ranges from individualized healthcare, security, shopping online, smart homes, and a host of others. As a result of the complexity of AI and the changes it has undergone, there is no clear-cut definition that will be all-inclusive incorporating the metamorphosis that

it has undergone from the 1980s to date (Luckin et al., 2016). The majority of the definitions of AI integrate two elements as the cardinal point: (i) thinking that is like humans, and (ii) rational actions (Russell & Norvig, 2009). Primarily, the name given to machines or computers that mimic man's cognitive functions like teaching and learning as well as the ability to solve problems as perfect as humans are called AI tools in education.

In the last decade, the world has been moving very swiftly towards the application of what is known as the fifth generation (5G) internet which is also labeled as the internet involving education. Interest in the corporation of artificial intelligence (AI) in teaching and learning is waxing very strong. The relevance of AI became very prominent when universities and schools were locked down due to the pandemic of coronavirus outbreak of 2019 (Darayseh, 2023).

Mahmoud's (2020) study reported that AI played diverse imminent roles in education. When AI is incorporated into the teaching and learning system, it creates chances for improvement in the educational section in terms of teachers' teaching and students' learning outcomes. Students learn in their space and individually by receiving personalized tutoring. Concepts that are ordinarily abstract can be presented in a form that will be understood by students, educators identify learning disabilities, and students get feedback on their progress as they progress in the study. With AI education is made global.

When AI is utilized during teaching and learning, especially in the form of cobots, enhanced learning experiences of students are fostered (Chassignol et al., 2018). Cobots have been applied to teach children tasks like spelling and pronunciation and they adjust to the student's abilities (Timms, 2016).

Personalized guidance, assistance, and evaluation by tailoring learning content based on student-specific learning patterns or knowledge levels are provided by AI tutoring systems (Hwang et al., 2020). Teaching with AI assists facilitators to save time as AI answers' students' non-complex, repeated questions via online discussion forums, and as such, teachers redirect the time saved to works of higher value (Goel & Polepeddi, 2016). The knowledge of learners' performance, progression, and potential are decoded by their clickstream data when AI is utilized in teaching and learning (Seo et al., 2021; Holstein et al., 2018).

From the foregoing, the relevance of AI in teaching and learning via the Internet and the development that has given access to both teachers and students to acquire the information they need cannot be overemphasized. Therefore, the need to enforce the utilization of AI and apply it in the plan of the curricula, teaching methods, and evaluation to have an efficient scholarship cannot be over-emphasized (Eltabakh, 2019).

In as much as an immense prospect is proffered by AI in education, its comprehensive utilization in the field of science education cannot be assured that teachers will apply it during teaching and learning. It also does not surety the standard of teaching since instructors have yet to imbibe the implementation steps of AI-based instruction (Ayanwale et al., 2022).

Also worthy of note is the attitudes of teachers toward the utilization of a new method of instruction. It is possible to find some teachers who will jettison a new method of teaching with the new technologies and continue teaching with the old method that they are familiar with. Teachers' restiveness toward new technologies and techniques

may stymie the attempt to use technology during teaching (H´ebert et al., 2021; Tallvid, 2016).

The importance of the classification of factors into relevance when sourcing alternatives to provide efficient usage of AI cannot be neglected. This research was undertaken due to the importance of adding to research seeking answers to the problems of the application of AI usage in the teaching of science via the instructors' angle.

Research gap and study objectives

From reviewed literature, most of the studies were carried out outside the continent of Africa. The sample size was not the same as in this study. Participants were not of the same ages as were involved in this study. The statistical tools for data analysis were not the same. For instance Darayseh, (2023) investigated the effect of teachers' years of teaching experiences that was in three groups and an independent t-test was used. This paper also used three groups but used analysis of variance to answer the research questions. Some of the studies reviewed were conducted in the higher education whereas this was carried out in secondary school.

Study objectives: The specific objectives of this study were to:

Pinpoint the variables affecting the effective usage of AI in sciences classroom.

Pinpoint the correlation among factors that foretell the approval of the usage of AI, the demeanor reasons for their effective application in teaching sciences.

Ascertain if there exists a significant difference at 05 degrees of freedom concerning teachers' sex, age, and residence location of the approval of the utilization of AI during science instruction.

Study problem

As part of the efforts to ensure Nigeria's educational sector is at par with global standards, stakeholders in Nigeria's education sector have urged the Federal Government to include Artificial Intelligence (AI), one of the global emerging technologies, in school curricula across the country. They pointed out that, if AI was adopted, it would adequately make for an easy learning experience for the learners and make teaching on the part of teachers easy and dynamic.

The Nigerian education system has suffered from a lot of setbacks. A beautiful curriculum will be designed but it will crash at the point of implementation. Stakeholders have started to urge the Federal Government of Nigeria to incorporate AI in the curriculum. From the aforementioned, science teachers are expected to have some level of competencies to be able to incorporate AI during the teaching of science. The curriculum of science is designed particularly to encourage students' engagement. Hence incorporating AI into teaching and learning spaces will be capable of enhancing learners' performance (Popenici & Kerr, 2017). Given the foregoing, it is necessary to undertake a study on factors that influence the utilization of AI in the sciences classroom using the technology acceptance model (TAM). The TAM is used to check for behavioral and external contributors that can be used to ascertain the demeanor and motives about the real employment of AI utilization in the teaching and learning of science. TAM was used in this research to elucidate the effect of identified external and internal factors that influence the approval of teachers in the sciences as they use AI.

Study questions: The purpose of this study was to investigate the factors that influence science teachers' AI utilization by employing TAM. This study, therefore, sought to answer these questions below:

1. How do science teachers utilize AI in teaching science in respect to the components of TAM?
2. During the teaching of science, what are the variables that influence the effective utilization of AI with regard to TAM?
3. Does science teachers' data like sex, age, and residence type affect science teacher use of AI?

Significance of the study: This study is relevant because it will provide information on the major variables affecting the approval of the usage of AI by science teachers. The study provided information for curriculum developers to take into cognizance when developing one. This study also provided information on the application of AI from the teachers' angle.

Literature review

Artificial intelligence in science education

A computer system that evolved via the manner man employs their nervous systems to comprehend, gain knowledge, ponder, and undertake reasonable initiative is termed AI (Stone et al., 2016). AI was established on the premise that intelligence can be expressed accurately such that a machine can mimic it.

At a higher level, AI can be associated with deftness akin to learning, fathoming conditions, proffering solutions, and communication in a natural way typical of man. The difference between AI and other computer programs is its capability to learn on its own (Kok et al., 2009).

The advancement in computers and the techniques for the procession of information, has become an integral part of the teaching and learning process. One aspect of AI in education is the supportive role it plays to instructors in their daily teaching activities like; writing lesson notes, homework, and learners' participation (Wang et al., 2020).

Some of the AI employed in education are;

1. Intelligent tutoring system

This is software used in education that has a part of AI incorporated into it. Learners' academic process pathway in terms of their assignment, readjustment in feedback and provide directions as the learning goes on. The software gets information on the student as the student progresses with it and can deduce the learner's level of competence or incompetence (Shute & Zapata-Rivera, 2010).

2. Teaching robots

Teaching robots include every robot that is utilized for the sole purpose of teaching and learning. When robots are used as tools, they are either utilized as a teaching tool for learners or used as an avenue to transmit knowledge as the robots are

manipulated. Robots used in education has been employed as instructional resources (Wang, 2004), learners' friend (Kory & Breazeal, 2014), and teaching aid (Han & Kim, 2009).

3. Learning analytics dashboards

An application that indicates learners' online conduct patterns in a virtually simulated instructional environment is termed a learning analytics dashboard. Learners' log files are monitored by the use of helping tools and digging large quantities of data to discover meaning by having a mental image of the results that will aid understanding from a surface view (Park & Jo, 2015).

4. Adaptive learning systems

The technologies that are capable of adjusting to the course contents and the learners' ability are called adaptive learning. The purpose is to improve students' learning outcomes in both teachers' instruction and machine learning (Capuano & Caballé, 2020).

Virtual reality (VR)

When AI is built into a very high-end computer, teaching can be done with it by evolving simulation and interface through numerous sensorial channels. These sensorial modalities involve the senses of sight, hearing, smell, feeling aural, and others (Kundalakesi et al., 2017). VR tools available for usage in the teaching of science are Labster Virtual and PhET simulation (Halabi, 2020; Xue and Wang, 2022).

Studies on the investigation of factors affecting teachers' adoption of AI abound but with the divergent reason for why teachers adopt AI in education in general and science in particular. Lack of AI resources as a factor affects the use of AI (Beri & Sharma, 2019; Kafyulilo et al., 2015; Palagolla & Wickramarachchi, 2019; Pima, 2019; Pima & Mtui, 2017). The heavy workload of teachers does not give them enough time to explore AI (Boettcher & Conrad, 2016; Dougherty, 2015). Teachers are not trained and do not have the technical support required to use AI (Ahmad et al., 2017; Asiri et al., 2012; Buabeng-Andoh, 2012). Teachers find AI very difficult to use and so do not adopt it (Sánchez-Prieto et al., 2019). Computer self-efficacy affects teachers' use of AI (John, 2015; Lestari & Indrasari, 2019; Rohatgi et al., 2016).

When teachers lack the basic knowledge of the availability and usage of AI-based teaching methods, it can affect their adoption (Buabeng-Andoh, 2012; Lawrence & Tar, 2018; Oye et al., 2012; Palagolla & Wickramarachchi, 2019; Pima & Mtui, 2017). Some instructors resist innovation in teaching (Beri & Sharma, 2019; Cleveland-Inne et al., 2018; Kisanga, 2016; Sánchez-Prieto et al., 2019).

Hwang et al. (2021) study on factors affecting the adoption of AI in higher education indicated that 7/10 of teacher willingness to adopt AI was attributed to self-efficacy, anxiety, usefulness, and comfort of use. Perceived ease and usefulness was a contributing factor to teachers' adoption of AI (Chocarro et al., 2021; Teo, 2019). The results of the study conducted by Buabeng-Andoh (2012) indicated that instructors' perceived ease of utilization of AI was a determinant factor for the utilization of AI in teaching and

learning. Perceived usefulness of AI Ukoh and Nicholas (2022) and risk of use (Li & Gu, 2023).

In a study conducted by Zhang et al. (2021) on factors influencing teachers' use of e-books in the teaching of artificial intelligence, results obtained showed that teachers' adoption of the e-book was influenced by their perception of the ease ofits utilization. Teachers are interested in the use of AI in the classroom but are handicapped in terms of how to use the AI tools. Training of teachers on the use of AI is very important. This therefore means that the ease of use of AI influences its' adoption by teachers. (Dimitriadou & Lanitis, 2023). When AI was used in Science Technology Engineering and Mathematics (STEM) education to assist teachers in their lesson delivery and the impact on students' achievement, an enhanced achievement was reported positive response in students' achievement (Deo et al., 2020; Hellings & Haelermans, 2020). Buenano-Fernandez et al. (2019) study on the use of AI in the teaching of computer engineering indicated a positive increase on the learning outcome of students. In the same vein, the study of Zabriskie et al. (2019) reported improved physics students' course outcomes.

Instructors in the education section are not clear on how they can use AI for pedagogical purposes and also how AI can affect teaching and learning in schools (Kengam, 2020). This calls for the need to investigate the nature of AI and its employability in the science classroom. Science instructors need to be armed with the nitty–gritty to surmount the issue of non -non-availability of resources for teaching and bad practices in teaching that have a relationship with the incorporation of AI into the classroom (Lindner & Romeike, 2019). The use of AI in schools may motivate the training of teachers to utilize current teaching techniques like the utilization of technology during teaching and learning.

From the literature reviewed, it is obvious that AI adoption in science education is lagging behind as evident by the scanty literature review in science education. Literature reviewed also indicated that AI in education is gaining ground in other continents, Africa in general and Nigeria in particular is left behind. Stakeholders in Nigeria are calling for the inclusion of AI in the school curricula especially in science education. But no matter how beautiful a curriculum is, teachers are the ones to implement it, and if they do not it becomes ugly. The question is 'Are Nigerian science teachers ready to implement the AI curriculum when put in place? There is, therefore, the need to investigate teachers' characteristics that will impact on the application of AI in the teaching and learning of science in the classrooms, AI merits, and its' durability when utilized by teachers in the sciences.

Technology acceptance model (TAM)

The relevance of users' approval of technological tools and applications in society has been a prominent study within the past decade. The TAM was developed to explain the behaviour of users as well as forecast the variables responsible for that behavior (Chuttur, 2009). For a user to accept a new technology, three factors are important; the perceived usefulness (PU), its perceived ease of use (PEOU), and user attitude towards its usage (ATU) (Mugo et al., 2017). The level of utility of a particular technology that a user thinks can increase their effectiveness in their job is perceived usefulness (PU). Perceived ease-of-use (PEOU) is the extent to which a user feels that a particular technology will

require a small amount of energy in its applicability and lastly, attitude towards its usage (ATU) is how the user conducts him/herself during the application of such technology (Davis, 1989). Chen et al. (2011) asserted that users' attitude toward the usage (ATU) of technology is highly dependent on perceived usefulness (PU) and perceived ease of use (PEOU).

This model proposes that teachers' use of technology is influenced by their presumed utility and presumed application which may influence their employability of technology directly or indirectly. Recently, progress has been made in TAM to incorporate factors like self-esteem, age, anxiousness/ stress, and confidence (Guner & Acarturk, 2020).

The study conducted by (Alrehaili & Alenezi, 2022) reported that perceived performance, presumed effort, and societal factors influenced teachers' acceptance of the utilization of technology (AI) in education. Owusu et al. (2022) study investigated the factors that influence adults' use of smartphones using TAM. The findings showed that performance perception (Pp) and social influence significantly impacted the behavioural intent (BI) and attention toward using smartphones (AT). In another study by Chocarro et al. (2021), it was indicated that the perceived ease and perceived utilization of AI (chatbots) facilitated its approval.

This study model was indicated in Fig. 1. It was arrived at through reviewed study and adapted into Davis 1985 TAM to ascertain the variables affecting the utilization of AI in the classroom.

Methodology

This study sought to classify, describe, compare, and measure data and also focused on the cause and effect of factors identified in this research as influencing the utilization of AI in science classrooms with the TAM. This study therefore employed the descriptive and analytical research design (McLeod et al., 2016). The objectives formulated in this study were achieved via a questionnaire. The questionnaire was used in the collection of data that were analysed at the end of the research and provided results for the study.

Participants

The population of this study comprised all science teachers in the Calabar Education Zone of Cross River State, Nigeria (CEZCRS). There are 170 science teachers in the (CEZCRS). This research took place during the 2022/2023 academic year. A simple random sampling technique was used to arrive at the sample of the study. The sample

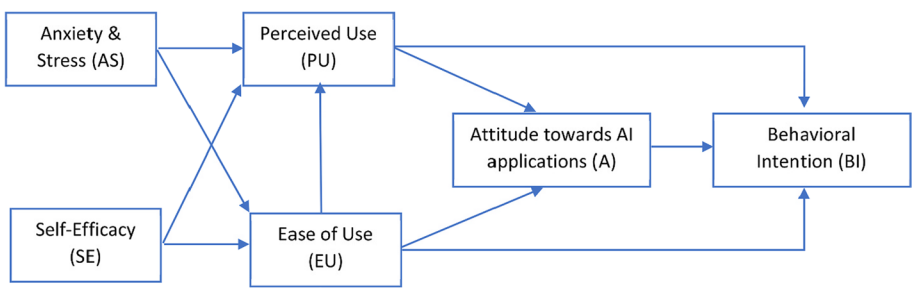

Fig. 1 The TAM is applied in this article

was made up of 79 science teachers comprising (58.22%) 46 females and (41.77%) 33 males. The sample distribution for participants indicated that teachers' age, 18.99% (15) are within the age bracket of 25–34 years of age, 31.65% (25) are 35–44 years of age, and 49.37% (39) are 45 and above years of age. Science teachers' information on residence location showed that 79.75% (63) were living in urban while 20.25% (16) were residents in rural areas.

Instrumentation: A questionnaire named 'Questionnaire Adoption of Artificial Intelligence: The Teachers' Eye' (AAITEQ). AAITEQ was adapted from the works of Chuttur (2009) and Davis (1989).

It was divided into two parts; A and B. Segment A contained personal data of teachers like; sex, age, and residence location. Segment B had 30 items that measured six factors which were self-esteem, stress and anxiousness, ease of utilization, behavioural intention, and attitude toward AI usage. They all had 4 items each. The variable of expected benefits contained 10 items. The items were rated on the modified 4-point Likert scale responses. A respondent scored 4 for strongly agreed (SA) and 1 for strongly disagree (SD) (See Additional file 1).

Validity and reliability

AAITEQ was presented to 3 experts in testing and measurement to ascertain the appropriateness, correctness, and suitability of the items in AAITEQ. Their comments and suggestions were incorporated into the final stage of the AAITEQ. Initially, there were 35 items and the final had 30 items. Five items were dropped for their inappropriateness and 3 items were modified. To ascertain the internal consistency of the items in the AAITEQ, it was administered to 25 science teachers in Ogoja Educational Zone who did not take part in the study but were equivalent to science teachers who were used for the study. Their responses were coded and analysed using the Person Product Moment coefficient. The results obtained ranged from 0.78 to 0.89. All the values obtained were statistically significant at 0.05 level.

The reliability of the instrument was also sought to measure how consistent the instrument was using Cronbach's alpha. The reliability coefficient results are presented in Table 1. The calculated value of the reliability using Cronbach's alpha ranged from 0.72 to 0.81. When the value obtained is 0.70 and above, the instrument is

Table 1 Reliability statistics of QAAITE

S/N	Variable name	No. of item	Cronbach's alpha coefficient
1	Self-Esteem	5	0.78
2	Stress and anxiousness	5	0.72
3	Ease of utilization	5	0.79
4	Behavioural intention	5	0.81
5	Attitude towards AI usage	5	0.76
6	Expected benefits	10	0.80
	Total	30	0.78

reliable (Hair et al., 2013). These values obtained are higher than 0.70 value and therefore the QAAITE is good enough to be used for the study.

Procedure

Researchers of this study obtained permission to carry out the research from the principals of the schools used for the research. The ethical consideration of the quality assurance of the Secondary School Education Board was taken into consideration. Consent of the participants was sought. They were told that the information required of them was exclusively for research purposes and that their anonymity was guaranteed. The teachers used in this research willingly consented and got involved in the study. The study took place during the first term of the 2022/2023 academic year. Research assistants helped in the distribution of the AAITEQ to respondents in their staff rooms during the break period for 35 min.

Data analysis

Analysis of data derived from the study was done using different statistical tools; means, standard deviations, percentages, frequencies, Pearson product Moment correlation coefficients, independent samples t-tests, and one-way analysis of Variance (ANOVA).

Results

Cronbach's alpha coefficient reliability for TAM variables used in the study is shown in Table 1. Behavioural intention had the highest reliability value of 0.81 and stress/ anxiousness had the lowest reliability value of 0.72.

This study raised 3 research questions that the study sought to answer and also to interpret and discuss the findings.

How do science teachers utilize AI in teaching science in respect to the components of TAM?

Table 2 was used to examine teachers' scores on the scale in each aspect of QAAITE Generally, the sample had above average scores in the 6 segment of QAAITE. The mean scores were between 2.10 (Stress and anxiousness) to 3.40 (Attitude towards AI usage) and a total score of 2.995 on a 4-point Likert-type scale.

During the teaching of science, what are the variables that influence the effective utilization of AI with regard to TAM?

Table 2 Descriptive statistics of teachers' scores on the scale in each aspect of QAAITE

S/N	Variable name	Mean	Position
1	Self-Esteem (SE)	3.89	1
2	Stress and anxiousness(SA)	2.10	6
3	Ease of utilization (EU)	2.50	5
4	Behavioural intention(BI)	2.98	4
5	Attitude towards AI usage.(A)	3.40	2
6	Expected benefits (EB)	3.10	3
	Average	3.00	

Table 3 First order inter correlation of the variables

S/N	Variables	1	2	3	4	5	6
1	Self-Esteem	1	0.096	0.159	0.247*	−0.009	0.142
2	Stress and anxiousness		1	0.017	0.227*	−0.035	−0.115
3	Ease of utilization			1	−0.093	0.234*	0.004
4	Behavioural intention				1	−0.048	0.146
5	Attitude towards AI usage					1	0.421**
6	Expected benefits						1

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Table 4 Factors pathways analysis

Factors pathways	Stand Reg	CoeffSta	ConfiCoeff	Sig. level	Result
Self-Esteem → Ease of utilization	0.416	0.171	2.290	0.022	Accept
Stress and anxiousness → Ease of utilization	0.048	0.074	0.649	0.516	Reject
Stress and anxiousness → Expected benefits	0.079	0.059	1.299	0.159	Reject
Ease of utilization → Expected benefits	0.591	0.138	3.905	***	Accept
Self-Esteem → Expected benefits	0.469	0.167	2.6575	0.007	Accept
Ease of utilization → Attitude towards AI usage	0.478	0.134	3.442	***	Accept
Expected benefits → Attitude towards AI usage	0.389	130	3.041	0.002	Accept
Expected benefits → Attitude towards AI usage	0.700	0.128	5.399	***	Accept
Attitude towards AI usage → Expected benefits	0.824	0.135	6.032	***	Accept
Expected benefits → Behavioural intention	0.022	0.121	0.099	0.928	Reject

Inter-Correlation Analysis The inter-correlations among the six factors of the QAAITE were determined using simple correlation. The results of the analysis using simple correlation were used to guarantee the absence of multiple correlations among the variables in the model. Results as presented in Table 3 showed the correlation value among all variables in the correlation to be less than 0.9, this implies that factors did not have multiple correlations.

The pathways analysis in Table 4 was used to investigate the variables influencing the effective utilization of AI in the teaching of sciences having in mind the part of the approved TAM. Table 4 indicated that seven pathways were significant whereas three were not significant. The coefficient paths using standard partial regression showed; Self-Esteem and Ease of utilization = 0.416; $P = <0.05$, Stress and anxiousness and Ease of utilization = 0.048; $P = <0.05$, Stress and anxiousness and Expected benefits = 0.079; $P = <0.05$, Ease of utilization and Expected benefits = 0.591 $P = <0.05$, Self-Esteem and Expected benefits = 0.469; $P = <0.05$, Ease of utilization and Attitude towards AI usage = 0.478; $P = <0.05$, Expected benefits and Attitude towards AI usage = 0.389 $P = <0.05$, Expected benefits and Attitude towards AI usage = 0.700 $P = <0.05$, Attitude towards AI usage and Expected benefits = 0.824; $P = <0.05$ and Expected benefits and Behavioural intention = 0.022; $P = <0.05$. For the variables with $P = <0.05$ it means the interaction between them is significant.

Table 5 indicates both the direct and indirect impact of the variables involved in this study through the coefficient of determination R^2. This was used to compute the

Table 5 Coefficient of determination (R^2)

Independent variable	Dependent variable	Partial regression	Coefficient (R)	Coefficient of determination (R^2)	Total E ffect	Direct Effec t	Indirect Ef fect
Self-Esteem	Ease of utilization	0.401	0.355	0.022	0.355	355	0
Ease of utilization	Expected benefits	0.600	0.539	***	0.539	0.539	0
Self-Efficacy	Expected benefits	0.459	0.366	0.008	0.549	0.366	0.195
Ease of use	Attitudes to AI usage	0.467	0.600	***	0.680	0.359	0.320
Expected benefits	Attitudes to AI usage	0.701	0.010	***	0.601	0.601	0
Expected benefits	Behavioural intention	0.014	0.271	0.904	0.455	0.010	0.445
Ease of use	Behavioural intention	0.393	0.740	0.001	0.789	0.270	515
Attitude to AI usage	Behavioural intention	0.820	0.729	***	0.729	0.729	0

Table 6 Independent sample t-test results for Sex differences in behavioural Intention

Sex	N	Mean	Std. deviation	t value	Significance level
Male	33	12.00	0.000		
Female	46	11.95	0.453	1.988	0.060

forecasting ability of the TAM. It had a value that ranged between 0 and 1 in which the higher the value the stronger the forecasting ability. As reported in Table 5, when the dependent and independent variables were combined, their total effect had a minimum value of 0.355 and a maximum value of 0.789. The higher the total effects number the greater the influence of the variables. The variable with the highest predicting value for ease of use and behaviour intent (0.789) and was seconded by attitude to AI usage and behavioural Intention (0.729).

Does science teachers' data like sex, age, and residence type affect science teacher use of AI?

An independent sample t-test as presented in Table 6 compared the behavioural intention of male and female science teachers in the utilization of AI. Analysis in Table 6 indicated a non-significant difference in value between male and female science teachers (t, 77 = 1.988; $p = 0.060$). The calculated p value of 0.060 was more than 0.05 hence the result of male and female science teachers for behavioural intention in the use of AI was not significant at a 0.05 level of significance.

One-way analysis of variance was used to determine the difference in behavioural intention about teachers' ages and was displayed in Table 7. The analyzed data in Table 7 indicated that science teachers within the age bracket of 25–34 had the lowest mean score of 11.93 and the least number of science teachers N = 15. Age bracket 45 and above had the highest number of science teachers and also the highest mean score (N = 39 and mean = 12.00.). That same Table 7 showed that F (2, 76) = 0.547

Table 7 Mean, standard deviation, and one-way ANOVA Results for Teachers' Age Difference in behavioural intention

Teachers' ages	N	Mean	Std. deviation
25–34	15	11.93	0.258
35–44	25	11.96	0.200
45 and above	39	12.00	0.229
Total	79	11.97	0.225

ANOVA

Sources of variations	Sum of squares	df	Mean square	F	Sig
Between Groups	0.056	2	0.028	0.547	0.581
Within Groups	3.893	76	0.051		
Total	3.949	78			

Table 8 Independent sample t-test results for teachers' residence location difference in Behavioural Intention

Residence location	N	Mean	Std. deviation	t value	Significance level
Rural	16	11.88	0.342	0.533	− 0.062
Urban	63	11.94	0.353		

with a p-value of 0.581 ($p > 0.05$) at a 0.05 level of significance. With the $p = > 0.05$, the result was not significant.

An independent t-test was used to ascertain the behavioural intention of science teachers in the utilization of AI concerning their residence location. The data analysis is presented in Table 8. Table 8 indicated a non-significant difference in value between rural and urban science teachers (t, $0.77 = 0.533$; $p = -0.062$). The calculated p value of -0.062 was more than 0.05 hence the result of rural and urban science teachers concerning behavioural intention in the use of AI was not significant at a 0.05 level of significance.

Discussion

The purpose of this study was to investigate the factors that influence science teachers' AI utilization by employing TAM. The name given to machines or computers that mimic man's cognitive functions like teaching and learning as well as the ability to solve problems as perfect as humans is artificial intelligence (AI). Three research questions were postulated thus;

1. How approving are science teachers of the utilization of AI in teaching science because of TAM?
2. While teaching science, what are those variables that influence the effective usage of AI?
3. Does teachers' personal data like sex, age, and residence location affect science teacher use of AI?

The first question of the study states thus; how approving are science teachers of the utilization of AI in teaching science given TAM? Findings from this study indicated that science teachers approved the integration of AI in the science classroom. The findings in this research as recorded in Table 2 indicated that the approval for the utilization of AI was high with an overall mean score of 3.00. A closer look at Table 2 indicated that the Self-Esteem variable produced the highest effect on the use of AI in science classes with a mean score of 3.89. Other variables in the study were arranged in descending order according to their effects thus; Attitude towards AI usage (3.40), expected benefits (3.10), behavioural intention (2.98), ease of utilization (2.50), and Stress and anxiousness (2.10).

Self-esteem contributed the most to the approval level because no matter how good AI is and the teachers do not have confidence in themselves that they can use it, AI will not be utilized. AI usefulness in teaching science may be influenced by perceived ease of use as what seems useful to a science teacher in this case utilization of AI will determine if it will be used or not. This research supports earlier studies by Zhao (2007) that reported that self-esteem is germane in teachers' approval of the technology, ease of use was collaborated by Buabeng-Andoh, (2012), the usefulness of AI was supported by Yang et al., (2022) and ease of utilization was collaborated by Condie and Livingston (2007).

The importance of self-esteem in the adoption of AI in education cannot be overemphasized. It is along this backdrop that (Guner & Acarturk, 2020) incorporated it into the TAM model. Self-esteem is the worth people ascribe to themselves. It has to do with one's inner thought of one self. If a teacher believes that he/she can use AI in teaching, then it will be adopted otherwise it will throw into the trash can. No one will willing want to disgrace him/herself before students by not able to use before the students.

The second research question stated thus: During teaching science, what are those variables that influence the efficiency of using AI?

Table 4 was used to answer the second research question. That Table 4 indicates the path analysis of the results to determine the variables influencing the efficiency of the utilization of AI in the science classroom by applying segments accepted by TAM. The results of the analysis as represented in Table 4 showed that ten pathways were employed in this study and seven were positively correlated. They were: Self-Esteem and Ease of utilization, Ease of utilization and Expected benefits, Self-Esteem, and Expected benefits, Ease of utilization and Attitude towards AI usage, Expected benefits and Attitude towards AI usage, Expected benefits and Attitude towards AI usage, Expected benefits and Attitude towards AI usage and Attitude towards AI usage and Expected benefits.

It can also be said that teachers' self-esteem in the utilization of AI would make science teachers incorporate AI in the classroom and reduce their stress /anxiety levels. When stress is reduced in the classroom, the work of the teacher will become fun as the relationship between ease of utilization and intent to use technologies is positively correlated (Teo, 2019). With the view that ease of utilization correlates positively with intending to use AI, it can be said that ease of utilization aids the behavioural intention of teachers in the usage of technologies.

Table 5 was used to check for the coefficient of determination. As reported in Table 5, when the dependent and independent variables were combined, their total

effect had a minimum value of 0.355 and a maximum value of 0.789. The variable with the highest predicting value for behaviour intent was the ease of use (0.789) and was seconded by attitude to AI usage (0.729).

One can say that the reason why the results showed that pattern can be because teachers' presumed less effort in the utilization of AI and also as the control of their essential skills in utilization would have increased their right stance and behavioural intent in the incorporation of AI in the classroom. The results of this study agreed with studies conducted before now. The studies of Davis (1989); Adekunle et al. (2022) reported the direct impact of presumed ease of utilization on presumed usage. Earlier researchers indicated the link between presumed usefulness and presumed efforts of usage. It was indicated that there was a direct link between presumed usefulness and the intent of use (Straub et al., 1995). There was also a direct link between presumed usefulness and presumed efforts of usage (Condie & Livingston, 2007; Zhao, 2007).

The results of the study further collaborated the study conducted by Zhang et al. (2021) on factors influencing teachers' use of e-books in the teaching of artificial intelligence, results obtained showed that teachers' adoption of the e-book was influenced by their perception of the ease of its utilization. Interest alone on the utilization of a resource is not enough but the ability and ease in the use of that resource is very important. When teachers are trained on the utilization of AI stools there will be ease in it use and as such teachers will employ AI in the classroom. (Dimitriadou & Lanitis, 2023).

In a similar vein, the findings of Buabeng-Andoh (2012) indicated that instructors' perceived ease of utilization of AI was a determinant factor for the utilization of AI in teaching and learning. Teachers' perception of the usefulness of AI was a contributed to teachers adoption of AI Ukoh and Nicholas (2022). The reports of (Li & Gu, 2023) findings is that teachers will use Ai only if they discover that the risk of use is low.

Research 3 stated that: Does science teachers' data of sex, age, and residence type affect science teacher use of AI? To answer this research question, means, independent sample t-test, and one-way analysis of variance (ANOVA) were employed. Findings, as presented in Table 6, showed that the t-test results for sex differences in behavioural Intention were t, 394 = 1.410; $p = 0.057$. The calculated p value of 0.057 was more than 0.05 at a 0.05 level of significance. The result was therefore not significant. This means that both male and female science teachers share the same behaviour intent in the utilization of AI.

Results in Table 7 of the one-way analysis of variance (ANCOVA) for the difference in teachers' ages about behaviour intent showed that the was F (2,76) 0.547with a p value of 0.581 ($p > 0.05$) at 0.05 level of significance. With the $p = > 0.05$. This result was not significant, implying that the ages of science teachers do not significantly influence their behaviour intent in the utilization of AI.

The findings as displayed in Table 8 for the influence of science teachers' residence location on behaviour intent in the utilization of AI showed a t-value of 0.533 and a non-significant p-value of.062 at the significance level of 0.05. With this type of result, where sex, age, and residence location showed non-significance results when compared to behavior intent of the utilization of AI, the study states that sex, age, and teachers' residence do not influence the behavior of science teachers' intention of the utilization of AI.

By implication, it can be said that the results are this way because, when training programmes are organized for science teachers in Nigeria, there is no distinction in terms of sex, age, or residence location. The results of this research align with those done by (Ahmad, 2019; Almousa, 2020; Darayseh, 2023) which also indicated no differences in the statistically computed results. Darayseh (2023) stated that the non-significant difference observed in teachers' adoption of AI with respect to gender and age was because teachers have similar circumstances and abilities and therefore there was no distinction between them.

Conclusion

In results of this study showed that teachers teaching the sciences exhibited an elevated level of approval for the utilization of AI during teaching and learning in science class. The findings also indicated that self-esteem, expected benefits, ease of utilization as well as attitudes to the utilization of AI produced the highest impact concerning teachers' behaviour intent in the utilization of AI. One can say that the reason why the results showed that pattern can be because teachers' presumed less effort in the utilization of AI and also as the control of their essential skills in utilization would have increased their right stance and behavioural intent in the corporation of AI in the classroom. This study also showed that the adoption of AI is dependent on the ease with which it can be utilized. Their drive toward AI is also the benefit they stand to derive from AI when it is used in the classroom. By these results, it is crystal clear that for educationists and managers of schools to effectively train science instructors, they need to investigate the potent means of curbing stress and anxiousness and encouraging instructors' self-esteem in the classroom. This can be done through periodically organizing workshops that will train teachers on the utilization of AI and getting them informed of the available AI tools and how they can be used in the science classroom. This may boost their favourable disposition toward the utilization of AI. And will increase their self-esteem in AI utility. From the results gathered from this study, the following recommendations were made; there should be workshops and seminars to train in-service science instructors on the utilization of AI. Knowledge gained from the workshop will enable teachers to adopt AI in their classes. That will make them master the use of AI tools and will lead to the high self-esteem of the teacher. During teachers' training programmes, AI should be incorporated in the programmes this will make teachers be conversant with the use of AI in the early stage of their careers and as such build self-esteem in the use of AI.A manual on how to effectively use AI and its tools should be distributed to both in-service and teachers in training. This is to enable teachers to learn about the application of AI even in their comfort zone. The curriculum of science subjects should be revised to accommodate AI tools. This is important as some teachers may not want to use anything outside the prescribed curriculum.

A prominent limitation of this study is that it was only centered on teachers who teach science subjects. The findings of this study when made to all science teachers should be conscious of the fact that not all teachers' data/information was used. For instance, the study did not investigate teachers' academic level, years of teaching experience, marital status, salary grade level, and a host of others. This study indicated that science teachers' approval level for the utilization of AI was very high. Among the variables examined in

this study, self-esteem produced the greatest influencing power on teachers' behaviour intent in the utilization of AI applications. Factors like expected benefits, ease of utilization, and attitudes to the utilization of AI also have greatly influenced the utilization of AI.

The Secondary school Board should set learning objectives that will comprise both teachers and students on the development of AI tools and skills. This study can play an important role for secondary schools that want to keep their students abreast with the newest innovation in science teaching. The method of teaching will bring about the transition from the ancient teaching style to the digital age teaching style. The AI laboratory when put in place can help teachers to practice its usage before class and that can boost teacher self-esteem on the usage. The design of the AI should be according to the user's needs and be easy to use. With the adoption of AI in the teaching and learning process errors of information in the classroom will be a thing of the past.

Abbreviations

AI	Artificial intelligence
AAITEQ	Approval of artificial intelligence: The Teachers' Eye' Questionnaire
CEZCRS	Calabar education zone of Cross River State, Nigeria
TAM	Technology acceptance model

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40561-023-00261-x.

Additional file 1. Questionnaire Adoption of Artificial Intelligence: The Teachers' Eye.

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Author contributions
NCO: Conceived and designed the questionnaire, interpreted the data and wrote the paper. I, KS: Administered the questionnaire, analysis tools or data and wrote the paper. U, UE: Analyzed the data and wrote the paper. MAN: Administered the questionnaire and Analyzed data. EEE: Interpreted the data and wrote the paper. ECM: Analyzed, interpreted the data and wrote the paper. U, JU: Contributed materials, analysis tools and wrote the paper. EOE: Administered the questionnaire, and wrote the paper. A, MI, Designed the questionnaire, and wrote the paper. CU, BA: Analyzed data and wrote the paper.

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