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INFLUENCE OF ADAPTIVE LEARNING SYSTEMS AND INTELLIGENT TUTORING SYSTEMS ON PERSONALIZED LEARNING AMONG BUSINESS EDUCATION STUDENTS IN PUBLIC UNIVERSITIES IN CROSS RIVER STATE, NIGERIA

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ABSTRACT
This study investigated the influence of adaptive learning systems and intelligent tutoring systems on personalized learning among business education students in public universities in Cross River State, Nigeria. Two research questions and one hypothesis were formulated to guide the investigation. A predictive correlational research design was adopted, using a structured questionnaire titled "Adaptive Learning Systems, Intelligent Tutoring Systems and Personalized Learning Questionnaire" (ALSITSPLQ) as the main instrument. The population comprised 311 final-year business education students from two public universities in Cross River State. The sample for the study comprised 169 respondents, representing 54.34% of the total population. The instrument was validated by three experts in university of Calabar and the reliability was established using Cronbach's alpha, which yielded coefficients of 0.89, 0.82 and 0.91, respectively. Research questions and hypotheses were analyzed using multiple regression analysis at 0.05 significance level. Findings revealed that adaptive learning systems ((B = 0.443, SE = 0.064, β = 0.440, t = 6.881, $p < 0.001$) and intelligent tutoring systems (ITS) (B = 0.525, SE = 0.064, β = 0.522, t = 8.159, $p < 0.001$) each significantly influence personalized learning among business education students in universities in Cross River State, Nigeria. The study concluded that adaptive learning systems and intelligent tutoring system may be useful tools for personalized learning in business education. It was recommended, among others, that business education lecturers in universities and other tertiary institutions should integrate adaptive learning systems into their instructional practices to provide personalised learning experiences that accommodate students' individual learning needs, abilities, interests, and learning paces.

Keywords: Adaptive Learning Systems, Intelligent Tutoring Systems, Personalized Learning, Business Education & public university

Introduction

Personalized learning is an educational approach in which teaching, learning content, instructional activities, assessment and feedback are adapted to the individual needs, abilities, interests, prior knowledge, learning pace and progress of each learner. It differs from the traditional "one-size-fits-all" approach because learners are provided with learning experiences that respond to their differences rather than being expected to learn identical content in exactly the same way. Khor and Mutthulakshmi (2024) viewed personalized learning as increasingly connected with digital technologies, learning analytics, adaptive learning systems and artificial intelligence (AI), which make it possible to collect and analyse information about learners and use such information to modify learning experiences. Personalized learning places the learner at the centre of the educational process. It recognizes that students enter the classroom with different levels of prior knowledge, interests, abilities, learning needs and levels of motivation. Consequently, instructional activities can be differentiated to address these differences. For example, learners who have difficulty understanding a particular topic may receive additional explanations, examples, tutorials and practice exercises, while learners who have already demonstrated mastery can proceed to more challenging activities. Personalized learning would help business education students to improve upon level of comprehension of the subject matter.

Business education is an important component of the educational system that prepares individuals with the knowledge, skills, competencies, attitudes, and values required to function effectively in business organisations, government establishments, and entrepreneurial ventures. Business education encompasses specialised areas such as accounting, office technology and management, marketing, entrepreneurship, and other business-related disciplines. These areas are designed to equip learners with the knowledge, practical skills, and competencies required for employment, entrepreneurship, and effective participation in the contemporary business environment (National Universities Commission [NUC], 2023). The relevance of these disciplines is further demonstrated by the need to implement business education curricula that respond to technological advancement, changing workplace requirements, and the acquisition of practical competencies (Nwatalari et al., 2025). However, the rapid advancement of digital technology, artificial intelligence (AI), globalisation, economic uncertainty, and changing employment patterns has created new challenges for business education. These developments require business education institutions to review their curricula, teaching methods, assessment practices, technological infrastructure, and relationships with employers. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023), although digital technology offers opportunities to improve teaching and learning, its effectiveness depends on equitable access, appropriate implementation, teacher preparedness, and the availability of reliable evidence regarding its educational value. To address these challenges, adaptive learning and Intelligent Tutoring Systems (ITS) become essential tools in the teaching of business education programme.

Adaptive learning refers to an instructional approach in which teaching strategies, learning materials, assessment activities, and feedback are adjusted continuously or periodically according to learners' performance, needs, progress, and demonstrated understanding. This approach seeks to make learning more responsive to individual differences by identifying areas of strength and difficulty and providing appropriate instructional support. In technology-supported learning environments, adaptive learning systems employ learner data, algorithms, and artificial intelligence (AI) to determine the type, sequence, difficulty, and pace of instructional activities suitable for individual students. Hariyanto et al. (2025) explained that AI-supported

adaptive education can utilise techniques such as machine learning and predictive analytics to analyse learners' performance and facilitate the personalisation of instructional experiences.

Adaptive learning has become an important concept in contemporary education because of the increasing need to provide learners with instructional experiences that respond to their individual learning needs, abilities, prior knowledge, learning progress, and academic challenges. Traditional classroom instruction often presents similar learning content, activities, and assessment procedures to students despite differences in their levels of understanding, learning abilities, and pace of learning. Adaptive learning seeks to address these limitations by modifying instructional content, learning activities, feedback, and assessment procedures in response to information about individual learners. According to Du et al. (2024), adaptive learning in higher education can support students' academic performance and engagement by responding to their individual learning requirements.

An intelligent tutoring system is a computer-based instructional application that uses artificial intelligence, learner modelling and pedagogical rules to simulate selected functions of a human tutor. It provides explanations, questions, hints, corrective feedback and learning recommendations based on the learner's current level of understanding (Luo et al., 2025). An ITS may identify an incorrect response, determine a possible misconception and guide the learner through the steps required to arrive at a correct solution (Letourneau et al., 2025). This makes the system different from a conventional digital learning platform that primarily distributes learning materials or administers standardised tests. The distinguishing feature of ITS is its ability to use information about the learner to inform subsequent instructional decisions (Luo et al., 2025).

Intelligent tutoring systems (ITS) have become an important aspect of educational technology because of their capacity to provide individualised instruction, adaptive learning experiences, immediate feedback and personalised academic support (Letourneau et al., 2025; Luo et al., 2025). The development of artificial intelligence has created opportunities for designing instructional systems that can respond to learners' needs, monitor their progress and provide appropriate guidance throughout the learning process (Merino-Campos, 2025). Unlike traditional computer-assisted instruction, which often presents the same content and exercises to all learners, intelligent tutoring systems use computational techniques to adjust instructional activities according to students' responses, demonstrated knowledge and learning. According to Letourneau et al. (2025), artificial intelligence-driven intelligent tutoring systems are increasingly being investigated as tools for improving teaching and learning through personalised instructional support. The study is therefore designed to ascertain the influence of artificial intelligence on personalized learning among business education students in public universities in Cross River State, Nigeria.

Statement of the problem

Personalised learning has become an important consideration in contemporary higher education because students differ in their prior knowledge, learning abilities, pace of understanding, interests and academic needs. Conventional instructional approaches have not provided sufficient opportunities to address these differences, particularly where lecturers must teach large classes using similar instructional materials and assessment procedures. Adaptive learning systems and intelligent tutoring systems offer opportunities to address this challenge by adjusting learning activities to students' demonstrated needs, providing individualised feedback and supporting learners as they progress towards specified learning objectives. Adaptive learning systems can modify instructional content, learning pathways and levels of difficulty according to

students' performance, while intelligent tutoring systems can provide explanations, hints, corrective feedback and guided problem-solving. However, the extent to which these technologies can support personalised learning depends on their availability, instructional quality, accessibility and effective integration into teaching and learning.

In Nigeria, the increasing attention given to artificial intelligence in education has created opportunities for investigating how AI-supported instructional technologies can improve students' learning experiences. Nevertheless, the availability of digital technologies does not necessarily mean that adaptive learning systems and intelligent tutoring systems are being effectively used to provide personalised learning in universities. UNESCO's Institute for Information Technologies in Education (2025) identifies adaptive learning platforms, AI-powered tutoring systems and learning analytics as emerging approaches for supporting personalised education and student success. Despite these opportunities, questions remain about the extent to which such technologies are accessible to students, appropriately integrated into university teaching and capable of responding to individual learning needs within particular educational contexts. Otum and Okute (2025) investigated the application of artificial intelligence in course delivery among business educators in public universities in Cross River State. The study highlighted infrastructural deficiencies, financial constraints, limited lecturer training and institutional barriers.

The specific research gap, therefore, is the limited context-specific evidence establishing the separate relationships of adaptive learning systems and intelligent tutoring systems with personalised learning among business education students in public universities in Cross River State, particularly when students' varying levels of exposure to these technologies are taken into account. Addressing this gap will provide evidence that can inform decisions concerning the integration of AI-supported instructional technologies into business education and the development of learning experiences that respond more effectively to students' individual needs. The problem of this study, therefore, is the lack of sufficient context-specific empirical evidence on the extent to which adaptive learning systems and intelligent tutoring systems relate to personalised learning among business education students in public universities in Cross River State, Nigeria.

Purpose of the study

The main objective of this study is to ascertained the influence of adaptive learning systems and intelligent tutoring systems on personalized learning among business education students in public universities in Cross River State, Nigeria. Specifically, the study sought to determine the influence of:

1. Adaptive learning systems on personalized learning among business education students in public universities in Cross River State, Nigeria.
2. Intelligent tutoring systems (ITS) on personalized learning among business education students in public universities in Cross River State, Nigeria.

Research questions

The following research questions were posed.

1. How do adaptive learning systems influence personalized learning among business education students in public universities in Cross River State, Nigeria?
2. How do intelligent tutoring systems (ITS) influence personalized learning among business education students in public universities in Cross River State, Nigeria?

Research hypothesis

The following null hypothesis was formulated and tested at 0.05 level of significance. Thus, the decision rule is that, when the p-value is ≤ 0.05 the null hypothesis is rejected and the alternate hypothesis is accepted and when the p-value is ≥ 0.05 the null hypothesis is retained and the alternate hypothesis is rejected.

1. There is no significant joint influence of adaptive learning systems and intelligent tutoring system on personalized learning among business education students in public universities in Cross River State, Nigeria. Regression analysis was used to answer the research question.

Literature review

Du et al. (2024) conducted a scoping review titled Personalized adaptive learning in higher education: A scoping review of key characteristics and impact on academic performance and engagement. The researchers examined 69 studies involving undergraduate students to determine the characteristics of personalised adaptive learning and its effects on academic performance and student engagement. Their findings showed that 41 studies, representing 59% of the studies reviewed, reported improvements in academic performance, while 25 studies, representing 36%, reported increased student engagement. The researchers also found that prior-knowledge quizzes were commonly used to determine when students should receive adaptive learning content. However, technological limitations and the time required to implement adaptive learning were identified as important challenges. The study concluded that adaptive learning has the potential to improve academic outcomes and engagement when appropriately implemented. Nevertheless, because the review covered different educational contexts and implementation approaches, the findings do not establish that every adaptive learning intervention produces positive outcomes.

Similarly, Hooshyar et al. (2024) investigated the effectiveness of personalised technology-enhanced learning in higher education through a meta-analysis and association-rule-mining approach. The researchers analysed 47 studies involving personalised technology-enhanced learning interventions to determine their effects on cognitive and non-cognitive learning outcomes. Their findings indicated that personalised technology-enhanced learning produced improvements in cognitive skills and non-cognitive characteristics, with an overall medium effect size. The researchers also found that the effectiveness of personalised learning varied according to factors such as the learning environment, delivery mode, and characteristics used to personalise instruction. Their findings suggest that adaptive learning is more likely to be effective when instructional decisions are aligned with learners' needs and the educational context. However, the study focused on technology-enhanced personalised learning broadly, meaning that its findings should not be interpreted as applying exclusively to fully automated adaptive learning systems.

Furthermore, Hariyanto et al. (2025) conducted a systematic review titled Artificial intelligence in adaptive education: A systematic review of techniques for personalized learning. The researchers examined 142 peer-reviewed empirical studies published between 2015 and 2025 to investigate how AI techniques support adaptive and personalised learning. Their review explored supervised learning, unsupervised learning, reinforcement learning, and multimodal analytics as approaches for analysing learner information and adjusting instructional experiences. The findings showed that adaptive learning techniques could support learner classification and performance prediction, while clustering techniques could identify patterns in students' learning behaviour. Reinforcement learning was also discussed as a method for dynamically sequencing

learning content. However, the researchers identified data privacy, model interpretability, scalability, and implementation in resource-constrained environments as continuing concerns. The study demonstrates the growing technological capacity for adaptive instruction while highlighting the need for appropriate infrastructure, transparent algorithms, and responsible data management.

Letourneau et al. (2025) conducted a systematic review of artificial intelligence-driven intelligent tutoring systems in primary and secondary education. Their review examined 28 studies involving 4,597 students. The findings generally indicated positive effects of ITS on students' learning and academic performance. However, the benefits were sometimes less pronounced when intelligent tutoring systems were compared with other well-designed instructional approaches. The authors therefore recommended further research involving larger and more diverse samples and longer intervention periods. These findings suggest that ITS can improve learning, but the technology should be evaluated against the quality of alternative teaching methods rather than assumed to be effective simply because it incorporates artificial intelligence.

Similarly, Luo et al. (2025) conducted a systematic review of 63 peer-reviewed studies examining the design and assessment of artificial intelligence-based learning tools in higher education. The researchers identified three major applications of these tools: assessment and evaluation, personalised feedback and recommendations, and intelligent tutoring. Of the reviewed studies, 26 employed AI-based tools for intelligent tutoring. The review highlighted the potential of these technologies to support cognitive learning, skill development and affective outcomes. It also showed that AI-supported learning tools can provide students with feedback and recommendations that respond to their learning needs. However, the findings indicated that the design and implementation of such tools must be carefully aligned with instructional objectives and educational contexts. For business education, this evidence suggests that ITS could be used to guide students through accounting calculations, spreadsheet operations, business decision-making exercises and simulated business situations while providing feedback on their performance.

Further evidence is provided by Son (2024), who conducted a systematic literature review of intelligent tutoring systems in mathematics education. The review examined studies published between 2003 and 2023 to determine how ITS had been integrated into mathematics teaching and learning. The findings showed that intelligent tutoring systems were commonly used to supplement existing instructional practices, although some recent applications had substantially transformed students' learning experiences. The systems were frequently applied to number operations, arithmetic, algebra and geometry. The review also found that the extent of technological integration varied according to the instructional objectives and the role assigned to teachers. These findings are relevant to business education because accounting, quantitative business analysis and other business-related subjects involve numerical reasoning, problem-solving and the application of procedures. ITS may help students practise these competencies through structured tasks and immediate corrective feedback. Nevertheless, evidence from mathematics education cannot automatically be generalised to all business education subjects.

Theoretical framework

The study was anchored on Self-Regulated Learning (SRL) Theory and Technology Acceptance Model (TAM).

Self-Regulated Learning (SRL) Theory is associated with the work of Barry Zimmerman, particularly his 2000 publication on attaining self-regulation. The theory explains how learners

actively participate in their own learning by setting goals, selecting strategies, monitoring their progress and evaluating their performance. Zimmerman (2000) conceptualised self-regulated learning as a cyclical process involving three major phases: forethought, performance and self-reflection. During the forethought phase, learners establish goals and plan their learning activities. During the performance phase, they implement learning strategies and monitor their progress. During the self-reflection phase, they evaluate their performance and use the results to guide subsequent learning activities. Self-Regulated Learning Theory provides a useful foundation for understanding the relationship between adaptive learning systems, intelligent tutoring systems and personalised learning among students. The principal strength of Self-Regulated Learning Theory is that it places learners at the centre of the learning process. It explains not only how instructional technologies can provide personalised learning experiences but also how learners can use feedback and learning information to improve their performance. However, self-regulated learning does not occur automatically whenever students use adaptive technologies. Its effectiveness depends on learners' motivation, digital competence, ability to interpret feedback and willingness to take responsibility for their learning. Consequently, adaptive learning systems and ITS should provide appropriate guidance without undermining students' independence.

The Technology Acceptance Model was developed by Davis (1989) to explain why individuals accept or reject information technology. The original model identifies two principal determinants of technology acceptance: perceived usefulness and perceived ease of use. Perceived usefulness refers to the extent to which an individual believes that using a technology will improve performance. Perceived ease of use refers to the extent to which the individual believes that using the technology will require minimal effort. Technology Acceptance Model (TAM) is relevant because the availability of adaptive learning systems and intelligent tutoring systems does not necessarily mean that students will use them effectively. Students are more likely to engage with these systems when they consider them useful, accessible and manageable. Students may be willing to use an intelligent tutoring system if they believe it will improve their understanding of accounting concepts, provide helpful feedback and support examination preparation. Conversely, complicated interfaces, unreliable internet access and limited digital competence may discourage their use. Similarly, students may perceive adaptive learning systems as useful when the systems provide relevant learning materials, identify knowledge gaps and recommend appropriate exercises. However, if students consider the recommendations irrelevant or the platform difficult to navigate, their willingness to use it may decline.

Methods

This study adopted a predictive correlational research design. The design has the capacity to determine the strength of the relationship between artificial intelligence (independent variable) and personalized learning (dependent variable). The population comprised 311 final-year business education students two public universities (University of Calabar (UNICAL) and University of Cross River State (UNICROSS), in Cross River State (see table 1). University of Education and Entrepreneurship, Akamkpa, is newly established so did not form part of the population. The Krejcie and Morgan sampling table was used to select a sample of 169 respondents. The sample was proportionately selected to give equal representation of the population under investigation The proportion of 54.34% of the population was used (see Table 2). Data were collected using a structured questionnaire titled “Adaptive Learning Systems, Intelligent Tutoring Systems and Personalized Learning Questionnaire” (ALSITSPLQ)”. The instruments contained 15 closed-ended questionnaire divided into two sections - A and B, with

four response options of: Strongly Agree (SA); Agree (A); Disagree (D) and Strongly Disagree (SD). Section A contained 10 items from the independent sub-variables and section B contained 5 items from the dependent variable. Respondents were given the freedom to tick the option that best suit their opinions without interference by the researcher. Items in the questionnaire were positively worded as Strongly Agree (SA) = 4; Agree (A) = 3; Disagree (D) = 2 and Strongly Disagree (SD) = 1. The instrument was validated by two business educators and a measurement and evaluation expert, university of Calabar. In order to ascertain the reliability of the instrument, a trial test was conducted on 10 final year business education students in university of Uyo. The Cronbach Alpha reliability technique was to used determine the internal consistency of the instrument which yielded the following reliability coefficients: Adaptive learning systems (0.89), Intelligent Tutoring Systems (0.82) and Personalized Learning (0.91), respectively. Data collected were analyzed using multiple regression analysis. The hypotheses were tested at the 0.05 significance level. The decision rule is that, when the p-value is ≤ 0.05 the null hypothesis is rejected and the alternate hypothesis is accepted and when the p-value is ≥ 0.05 the null hypothesis is retained and the alternate hypothesis is rejected.

TABLE 1
Population distribution of the population

S/N	Institution	Population
1	University of Calabar	53
2	University of Cross River State	258
	Total	311

Source: Office of the Departmental Examination Officer (2026)

TABLE 2
Sample distribution of the population

S/N	Institution	Population
1	University of Calabar	29
2	University of Cross River State	140
	Total	169

Source: Researcher (2026)

Results

Research question one

How do adaptive learning systems influence personalized learning among business education students in public universities in Cross River State, Nigeria? Multiple regression analysis was used to answer the research question. The result is presented on Table 3.

Table 3
Multiple regression analysis of adaptive learning systems on personalized learning among business education students in public universities in Cross River State, Nigeria, N=169

B	Std. error	β	t	p
.443	.064	.440	6.881	.000

Source: Fieldwork, (2026)

The results show that adaptive learning systems have a positive and statistically significant influence on personalized learning (B = 0.443, SE = 0.064, β = 0.440, t = 6.881, p <

0.001). This implies that a one-unit increase in adaptive learning systems is associated with a 0.443-unit increase in personalized learning, holding intelligent tutoring systems constant. The standardized beta coefficient of 0.440 indicates a positive contribution to personalized learning. Since the significance value is 0.000 ($p < 0.001$), which is less than the 0.05 significance level, the influence is statistically significant. Therefore, adaptive learning systems significantly predict personalized learning.

Research question two

How do intelligent tutoring systems (ITS) influence personalized learning among business education students in public universities in Cross River State, Nigeria? Multiple regression analysis was used to answer the research question. The result is presented on Table 4.

TABLE 4

Multiple regression analysis of intelligent tutoring systems (ITS) on personalized learning among business education students in public universities in Cross River State, Nigeria, N=169

B	Std. error	β	t	p
.525	.064	.522	8.159	.000

Source: Fieldwork, (2026)

The results indicate that intelligent tutoring systems have a positive and statistically significant influence on personalized learning ($B = 0.525$, $SE = 0.064$, $\beta = 0.522$, $t = 8.159$, $p < 0.001$). This means that a one-unit increase in intelligent tutoring systems is associated with a 0.525-unit increase in personalized learning, holding adaptive learning systems constant. The standardized beta coefficient of 0.522 indicates a positive contribution to personalized learning. Since the significance value is 0.000 ($p < 0.001$), which is below the 0.05 significance level, the influence is statistically significant. Therefore, intelligent tutoring systems significantly predict personalized learning.

Hypothesis testing

There is no significant joint influence of adaptive learning systems and intelligent tutoring system on personalized learning among business education students in public universities in Cross River State, Nigeria. Multiple regression analysis was used to answer the research question. The result is presented on Table 5.

TABLE 5

Multiple regression analysis of adaptive learning systems and intelligent tutoring system on personalized learning among business education students in public universities in Cross River State, Nigeria, N=169

R	R Square	Adjusted R Square	Std. error of the estimate	
.941	.885	.883	.352	
Source of variation	SS	Df	MS	F-ratio	P-value
Regression	158.053	2	79.026	636.140	.000
Residual	20.622	166	.124		
Total	178.675	168			

Source: Researcher (2026)

The results of the multiple linear regression analysis revealed that adaptive learning systems and intelligent tutoring systems jointly explained 88.5% of the variation in the dependent variable, as indicated by the coefficient of determination ($R^2 = 0.885$). The adjusted R^2 value of 0.883 further indicated that the model explained 88.3% of the variation after

adjusting for the number of predictors and sample size. The multiple correlation coefficient (R = 0.941) indicated a very strong relationship between the predictors and the dependent variable.

Furthermore, the ANOVA results showed that the regression model was statistically significant, $F(2, 166) = 636.140$, $p < 0.001$. This implies that adaptive learning systems and intelligent tutoring systems jointly made a statistically significant contribution to predicting the dependent variable. Consequently, the null hypothesis that the two predictors do not jointly significantly predict the dependent variable is rejected at the 0.05 level of significance and the alternate hypothesis is accepted that there is a significant joint prediction of adaptive learning systems and intelligent tutoring system on personalized learning among business education students in public universities in Cross River State, Nigeria.

Discussion

The finding shows that adaptive learning systems significantly influence personalized learning among business education students in public universities in Cross River State, Nigeria. Adaptive learning systems can adjust learning materials, tasks and assessments to students' individual abilities, progress and learning needs. This flexibility may enable students to learn at their own pace, concentrate on areas where they experience difficulties and receive relevant learning resources. The finding is supported by Du et al. (2024) that adaptive learning has the potential to improve academic outcomes and engagement when appropriately implemented. The finding further agrees with that of Hooshyar et al. (2024) that adaptive learning is more likely to be effective when instructional decisions are aligned with learners' needs and the educational context. Similarly, the finding agrees with that of Hariyanto et al. (2025) that supervised adaptive learning techniques could support learner classification and performance prediction.

The finding also shows that intelligent tutoring systems (ITS) significantly influence personalized learning among business education students in the study area. Intelligent tutoring systems can simulate certain functions of a human tutor by providing personalised explanations, immediate feedback, hints and remedial activities. This individualised support may help students identify and correct errors, understand difficult concepts and improve their learning experiences. The finding agrees with that of Letourneau et al. (2025) who indicated positive effects of intelligent tutoring systems on students' learning and academic performance. Similarly, the finding agrees with that of Luo et al. (2025) that intelligent tutoring system is used to guide students through accounting calculations, spreadsheet operations, business decision-making exercises and simulated business situations while providing feedback on their performance. The finding is also in tandem with that of Son (2024), that intelligent tutoring systems are commonly used to supplement existing instructional practices, although some recent applications had substantially transformed students' learning experiences.

Implications of the study

The relatively higher standardised coefficient for intelligent tutoring systems suggests that institutions may wish to investigate their potential for providing individualised academic support. However, this finding should not be treated as proof that they are universally more effective than adaptive learning systems. In subjects such as accounting, business mathematics, financial management and data processing, these technologies could provide individualised exercises, step-by-step explanations and immediate feedback to support students' learning.

Conclusion

This study demonstrates that adaptive learning systems and intelligent tutoring systems are valuable tools for advancing personalized instruction among Business Education learners in Cross River State, Nigeria. Findings show that adaptive learning systems and ITS significantly

predict personalized learning among the students. The study further shows that ITS significantly predict personalized learning.

Additionally, the study underscores the growing relevance of technology-enhanced learning and reinforces the need for continued adoption and refinement of AI-driven instructional tools in universities.

Limitations of the study

Despite the positive findings, several limitations were acknowledged. First, the regression analysis establishes statistical relationships based on the model and data used, but it may not automatically prove that adaptive learning systems and intelligent tutoring systems cause improvements in personalised learning. The study's research design is important in determining the strength of causal conclusions. Second, the findings may be affected by respondents' perceptions. Other factors, such as students' digital literacy, lecturers' technological competence, internet accessibility, motivation and institutional support, may also influence personalised learning. Finally, the findings may not apply equally to all institutions, disciplines or categories of students. Their applicability depends on the study population, sample size, sampling procedure and educational context.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Business education lecturers in universities and other tertiary institutions should integrate adaptive learning systems into their instructional practices to provide personalised learning experiences that accommodate students' individual learning needs, abilities, interests, and learning paces.
2. Tertiary institutions should encourage the adoption of intelligent tutoring systems to provide individualised guidance, immediate feedback, and targeted academic support to business education students, thereby improving their learning experiences and understanding of course content.
3. University management and relevant government agencies should provide adequate ICT facilities, reliable internet connectivity, electricity, and digital learning resources to facilitate the effective implementation of adaptive learning systems and intelligent tutoring systems.
4. University management should organize regular training programmes for business education lecturers to equip them with the digital competencies required to select, integrate, and effectively utilise adaptive learning systems and intelligent tutoring systems for personalised instruction.

Suggestions for further research

Based on the scope and limitations of the study, further study could be carried out in the following areas, to serve as a basis go comparison:

1. Comparative effectiveness of adaptive learning systems and intelligent tutoring systems on personalised learning and academic achievement among business education students in Nigerian Universities.
2. Lecturers' digital competencies and institutional readiness for AI-driven personalised learning in business education programmes in Nigerian Universities.
3. Adaptive learning systems, student engagement, and academic achievement in accounting education: A Quasi-Experimental Study.

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