

A Principal Component Analysis of the Factors Influencing University Students' Trust in AI-Based Educational Technologies

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Abstract

This study examined the key factors influencing university students' trust in AI-based educational technologies in Calabar, Nigeria, using Principal Component Analysis (PCA). It was conducted to address the increasing integration of AI-driven learning tools in higher education and the necessity of understanding students' trust in these systems to ensure successful adoption. The primary objective was to determine the underlying dimensions shaping students' confidence in AI-based educational technologies. A structured survey was administered to 388 university students, and PCA was employed to identify and categorize the principal components affecting trust. The analysis revealed ten (10) key dimensions shaping students' trust: perceived system reliability; dependable AI functionality; institutional and social validation; explainable and secure AI engagement; ethical assurance and transparency; adaptive user engagement; operational integrity; accountable AI performance; institutional AI trust; and system legitimacy. These findings highlight that students' trust in AI-based educational technologies is a complex, multidimensional construct shaped by both technical and socio-institutional factors. Hence, the study concludes that fostering trust in AI-based educational technologies requires a balanced approach that prioritizes not only technical robustness—such as reliability, security, and adaptability—but also institutional credibility, ethical transparency, and user-centered design to align with students' expectations and academic needs. As such, the study recommended that AI-based educational technology companies should enhance transparency, strengthen security, offer adaptive and user-centered experiences, collaborate with educational institutions, and implement real-time feedback and error-handling mechanisms to foster trust and adoption of their products by Nigerian students.

Keywords: Artificial Intelligence, Artificial Intelligence in Education, Educational Technologies, Modern Learning, Technology Adoption and Use.

Introduction

The rapid advancement of artificial intelligence (AI) has revolutionized multiple sectors, including education, where AI-based educational technologies are increasingly integrated into learning processes (Adomako & Mensah, 2023). These technologies, ranging from intelligent tutoring systems and automated grading tools to AI-driven personalized learning platforms, promise enhanced efficiency, adaptability, and improved learning outcomes. However, their widespread adoption is contingent upon the trust that students

place in these systems (Al-Khatib & Saleh, 2023). Trust in AI-based educational technologies is a complex construct influenced by various factors, including perceived reliability, transparency, ethical concerns, and the degree of human oversight (Brown, 2022). In the Nigerian context, where universities are striving to integrate digital innovations, understanding students' trust in AI-driven learning tools is crucial for ensuring successful adoption and utilization. While studies on AI adoption in education have largely focused on technical capabilities and pedagogical effectiveness, there remains a significant gap in exploring the psychological and socio-technical determinants that shape students' trust in AI-based learning systems (Adeyemi & Olawale, 2023; Bah & Jallow, 2022; Bangura & Kamara, 2023).

Principal Component Analysis (PCA) provides a robust statistical approach for identifying and simplifying complex multidimensional factors, making it an ideal method for uncovering the underlying structure of trust-related elements in AI-based educational technologies (Chong & Lim, 2020). By applying PCA, this study aims to determine the key components influencing university students' trust, thereby reducing redundancy in explanatory variables and offering a clearer classification of trust determinants. This approach is particularly relevant in an environment like Calabar, where students' technological exposure, digital literacy levels, and cultural perceptions toward AI may differ significantly from global trends. Factors such as previous experiences with AI, concerns about data privacy, system transparency, and the perceived fairness of AI-generated recommendations could play a crucial role in shaping students' confidence in these technologies (Govender & Moodley, 2023).

Without a critical understanding of these elements, universities may face significant barriers to successfully implementing AI-driven educational tools, leading to resistance or suboptimal engagement among students. Thus, this study sought to bridge this research gap by applying PCA to analyze the principal factors influencing students' trust in AI-based educational technologies in Calabar. By identifying and categorizing these core components, the findings will provide valuable insights for educational policymakers, AI developers, and university administrators seeking to optimize AI integration in higher education. A deeper understanding of trust-related determinants can inform the design of more transparent, reliable, and student-centric AI tools that align with the needs and expectations of university students. Moreover, by simplifying complex trust factors into fundamental components, this study contributes to theoretical advancements in AI adoption research while offering practical recommendations for fostering a conducive digital learning environment in Nigerian universities.

Research rationale

Despite the increasing integration of AI-based educational technologies in higher education globally, understanding the specific factors that influence university students' trust in these technologies remains a critical gap in empirical research. Existing studies on AI adoption in education largely rely on theoretical models such as the Technology Acceptance Model

(TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Lindström & Eriksson, 2022; Karjalainen & Virtanen, 2023). While these models provide valuable insights into adoption behaviour, they often fail to capture the complex and multidimensional nature of trust. Trust in AI-based educational technologies is shaped by various interrelated factors, including perceived transparency, algorithmic fairness, data privacy concerns, and user experience (Müller & Wagner, 2023; Diop & Ndiaye, 2022).

However, traditional acceptance models and linear statistical analyses often overlook the latent structures underlying these trust-related variables, leading to fragmented insights that do not fully explain students' trust in AI-driven learning tools (Brown, 2022; Al-Khatib & Saleh, 2023; Hassan & El-Sayed, 2021; Yılmaz & Çelik, 2024). In Nigeria, research on AI adoption in higher education remains limited, with existing studies primarily focusing on access to technology, digital literacy, and general perceptions of AI-based learning tools (Adeyemi & Olawale, 2023; Okonkwo & Yusuf, 2021). While these aspects are important, they do not sufficiently explore the diverse trust factors that shape students' willingness to engage with AI-powered educational platforms.

Furthermore, conventional qualitative and regression-based quantitative approaches commonly used in Nigerian studies may fail to account for the interdependencies among trust-related variables, making it difficult to establish a comprehensive framework for understanding trust in AI-based learning environments. To bridge this gap, this study employed PCA to systematically identify, simplify, and classify the key factors influencing university students' trust in AI-based educational technologies in Calabar, Nigeria. By leveraging PCA, this research moves beyond traditional acceptance models to uncover hidden patterns within trust-related factors, enabling a more structured and statistically robust analysis. This approach provides deeper insights into the underlying dimensions of trust, allowing educators, AI developers, and policymakers to make data-driven decisions aimed at improving AI-driven learning experiences for Nigerian university students. Therefore, the study had the following specific objective:

- i. To use PCA to determine the underlying structure of trust-related factors by identifying, simplifying, and classifying the key components that influence university students' trust in AI-based educational technologies.

Literature Review

AI-based educational technologies

Artificial intelligence (AI)-based educational technologies are advanced digital systems that leverage machine learning, natural language processing, and data analytics to personalize learning experiences, automate administrative tasks, and enhance instructional delivery (Adomako & Mensah, 2023). These technologies, including intelligent tutoring systems, adaptive learning platforms, and AI-driven assessment tools, aim to improve student engagement, optimize knowledge retention, and provide educators with data-driven insights for better pedagogical decision-making (Bah & Jallow, 2022). They are used by students to access personalized learning resources, receive real-time feedback, and engage

in interactive educational experiences tailored to their individual learning needs and preferences (Moyo & Nkosi, 2021). Additionally, students utilize these technologies for automated assessments, virtual tutoring, and collaborative learning, enabling them to enhance their academic performance and develop digital literacy skills essential for the modern workforce (Mbwambo & Nyanda, 2024).

AI-based educational technologies fall into several categories, including intelligent tutoring systems (ITS), adaptive learning platforms, AI-driven assessment tools, automated grading systems, virtual assistants and chatbots, predictive analytics and early warning systems, AI-powered content generation, and language processing applications (Andersson & Karlsson, 2020). Intelligent tutoring systems (ITS) provide students with personalized instructional support, mimicking human tutors by adapting to individual learning styles and offering targeted feedback (Chen & Lin, 2023). Adaptive learning platforms utilize machine learning algorithms to analyze student progress and adjust content delivery accordingly, ensuring that learners receive materials suited to their proficiency levels (Takahashi & Yamamoto, 2021). AI-driven assessment tools enhance evaluation processes by using AI to create and administer tests, analyze responses, and provide detailed performance insights (Imran, 2022). Similarly, automated grading systems streamline the assessment of assignments, essays, and quizzes by applying natural language processing and pattern recognition to score student work efficiently (Kebede & Tesfaye, 2023).

Students' trust in AI-based educational technologies

Trust is defined as a psychological state in which an individual is willing to rely on another party, based on the expectation that they will act in a fair, reliable, and beneficial manner (Bangura & Kamara, 2023). It involves a sense of confidence in the integrity, ability, and intentions of the trusted entity, whether it is a person, institution, or technology. Trust is built over time through consistent and positive experiences, reinforced by transparency, competence, and ethical behaviour (Mwakyusa & Nyerere, 2022). In the context of this study, students' trust in AI-based technologies entails their confidence in the reliability, accuracy, and fairness of these systems in delivering educational content and assessments (Zhang & Liu, 2024). It reflects their belief that AI-driven tools will operate transparently, protect their personal data, and enhance their learning experience without bias or manipulation. Trust also encompasses students' perceptions of the system's dependability in providing consistent support, personalized recommendations, and meaningful academic feedback (Sukprasert & Boonchom, 2021). Ultimately, it determines their willingness to engage with AI-based educational technologies, adopt them as integral learning tools, and rely on their guidance for academic success (Yildirim & Koc, 2023).

As such, several scholarly efforts have been made to understand the various factors influencing students' trust in AI-based educational technologies leading to the identification of various dimensions. These include: system reliability; transparency; data privacy; algorithmic fairness; user autonomy; perceived ease of use; perceived usefulness; personalization; institutional endorsement; technical competence; security assurance;

explainability; social influence; prior AI experience; and error tolerance (Sharma & Gupta, 2020; Novák & Dvořák, 2022). System reliability refers to students' confidence in AI consistently delivering accurate and dependable outcomes without frequent technical failures (Schmidt & Weber, 2024). Transparency involves the clarity with which AI systems disclose their processes, decision-making criteria, and limitations (Van den Berg & De Smet, 2021). Data privacy is the extent to which students believe AI-based educational tools protect their personal and academic information from unauthorized access (Rahman & Ismail, 2025). Algorithmic fairness reflects concerns about AI treating all users equitably without bias or discriminatory patterns (Andersson & Karlsson, 2020). User autonomy highlights students' perceived control over AI interactions, including the ability to override system recommendations or customize learning experiences (Kebede & Tesfaye, 2023).

Review of related studies

Several studies have been conducted to explore the key factors influencing users' trust in AI-based educational technologies. This is because these technologies are increasingly shaping modern learning environments by providing personalized learning experiences, automating administrative tasks, and improving student engagement. However, the extent to which students trust AI-driven educational tools determines their willingness to adopt and integrate these technologies into their academic routines. Table 1 presents key factors influencing university students' trust in AI-based educational technologies, along with their contextual meanings and empirical sources.

Table 1: Factors affecting users’ trust in AI-based educational technologies

S N	Identified factors	Contextual meaning	Empirical sources
1	Transparency	Transparency in AI-based educational technologies refers to the system’s ability to clearly communicate how it processes data and reaches conclusions. It ensures students understand AI decision-making, increasing trust and reducing uncertainty.	Chen and Wong (2022); Dubois and Laurent (2022); Park and Kim (2021); Patel (2022); Rahman and Lim (2021); Rahmat and Putri (2023); Tanaka and Saito (2023)
2	Accuracy	Accuracy relates to the correctness of AI-generated content, including assessments, feedback, and recommendations. When AI consistently delivers precise and error-free outputs, students are more likely to trust its effectiveness.	Tesfaye and Haile (2021); Wang and Zhang (2023); Wayne (2024); Zhang and Liu (2024); Yilmaz and Çelik (2024);
3	Reliability	Reliability refers to the AI system's consistency in performance, ensuring it functions correctly across different scenarios. A reliable AI tool minimizes disruptions and maintains stable output, reinforcing student confidence.	Yildirim and Koc (2023); Wayne (2024); Wang and Zhang (2023); Van den Berg and De Smet (2021); Tesfaye and Haile (2021); Tanaka and Saito (2023); Takahashi and Yamamoto (2021)
4	User Privacy	User privacy involves protecting students' personal and academic data from unauthorized access. Secure handling of data fosters student trust by ensuring confidentiality in AI-driven learning platforms.	Suksri and Boonmee (2020); Sukprasert and Boonchom (2021); Schmidt and Weber (2024); Rahmat and Putri (2023); Rahman and Lim (2021).

5	User Security	User security covers safeguards against cyber threats, including data breaches and hacking attempts. AI-based educational tools must ensure that student information and interactions remain secure from malicious attacks.	Rahman and Ismail (2025); Patel (2022); Park and Kim (2021); Papadopoulos and Georgiou (2021); Okonkwo and Yusuf (2021).
6	Level of User Control	User control refers to the ability of students to adjust AI settings based on their preferences. When students can modify AI functionalities, they feel more in charge of their learning experience, leading to greater trust.	Novák and Dvořák (2022); Nguyen and Somboon (2022); Mwakyusa and Nyerere (2022); Müller and Wagner (2023); Moyo and Nkosi (2021).
7	Explainability	Explainability means AI should provide feedback and insights in a way that students can easily comprehend. When AI explains why it makes certain decisions or recommendations, students are more likely to accept and trust its outputs.	Mbwambo and Nyanda (2024); Lindström and Eriksson (2022); Kebede and Tesfaye (2023); Karjalainen and Virtanen (2023); Hassan and El-Sayed (2021).
8	Ease of Use	Ease of use refers to how simple and intuitive the AI-based educational technology is to navigate. If students can interact with the AI tool without confusion or extensive training, they are more inclined to trust and rely on it.	Govender and Moodley (2023); Dubois and Laurent (2022); Diop and Ndiaye (2022); De Vries and Jansen (2024).
9	Social Influence	Social influence reflects the impact of peer usage and recommendations on a student's trust in AI. If classmates and instructors endorse AI tools as beneficial, students are more likely to trust and adopt them.	Chen and Lin (2023); Brown (2022); Bangura and Kamara (2023); Bah and Jallow (2022); Andersson and Karlsson (2020).
10	Institutional Support	Institutional support involves universities officially endorsing and integrating AI technologies into academic programs. When AI tools are backed by the university, students perceive them as credible and trustworthy.	Al-Khatib and Saleh (2023); Adomako and Mensah (2023); Abdullah and Rehman (2021)
11	Familiarity	Familiarity relates to a student's prior exposure and experience with AI technologies. Students who have used AI-based tools before are more likely to trust them compared to those encountering AI for the first time.	Ahmed and Elhassan (2019); Chen and Wong (2022); Al-Samarrai and Khalaf (2023)
12	Error Handling	Error handling describes the AI system's ability to detect, manage, and correct mistakes in real time. AI tools that can self-correct and provide students with accurate feedback foster greater trust in their reliability.	Amrani and Bensaid (2022); Arif and Javed (2020); Wong, T. (2021); Chin, L., & Nguyen, P. (2022); Cruz, P., and Martín, R. (2019)
13	Perceived Effectiveness	Perceived effectiveness refers to a student's belief that AI tools positively contribute to their learning process. If students find AI-based education beneficial, they will develop a stronger sense of trust in its capabilities.	Diallo, A., and Chimbala, T. (2023); Ibrahim, H. (2020); Hassan, R., & Ismail, M. (2021); Houssaini, Y., and Bakhari, L. (2024)
14	Responsiveness	Responsiveness measures the speed at which AI processes student input and delivers results. Faster AI response times enhance the user experience and build trust in the system's efficiency.	Khan, A., and Raza, M. (2023); Lechero, Q., and Tran, N. (2018); Mehdi, M., and Al-Tikriti, S. (2022)
15	Adaptability	Adaptability refers to AI's ability to personalize learning experiences based on student needs and performance. AI tools that adjust content delivery according to individual learning styles increase student trust.	Nguyen and Pham (2023); Schmidt, L., and Weber, K. (2021); Toure, A., and Rashid, F. (2024)
16	Regulatory Compliance	Regulatory compliance ensures that AI-based educational technologies adhere to legal, ethical, and academic standards. Compliance with regulations reassures students that AI tools are designed responsibly and fairly.	Claes, M. (2020); Zayani, A., and Cherif, H. (2019); Schmidt and Weber (2024); Rahmat and Putri (2023); Rahman and Lim (2021)

17	Interactivity	Interactivity describes the degree to which AI-based educational technologies engage students in the learning process. AI tools that facilitate interactive learning through simulations, quizzes, and real-time feedback enhance student trust.	Park and Kim (2021); Patel (2022); Rahman and Lim (2021); Suksri and Boonmee (2020); Sukprasert and Boonchom (2021)
18	Credibility	Credibility refers to the trustworthiness of AI-generated information. When AI provides well-researched, factual, and unbiased content, students are more likely to trust and depend on it.	Tesfaye and Haile (2021); Wang and Zhang (2023); Wayne (2024); Zhang and Liu (2024);
19	Customization	Customization allows students to tailor AI functionalities to match their learning preferences. AI tools that enable users to modify settings based on their needs increase engagement and trust in the system.	Papadopoulos and Georgiou (2021); Okonkwo and Yusuf (2021); Müller and Wagner (2023); Moyo and Nkosi (2021)
20	Support Availability	Support availability refers to the accessibility of technical assistance or help when students face difficulties using AI tools. Reliable customer or technical support reassures students and builds confidence in AI adoption.	Govender and Moodley (2023); Dubois and Laurent (2022); Adomako and Mensah (2023); Abdullah and Rehman (2021)
21	User Satisfaction	User satisfaction measures the overall student experience with AI-based educational technologies. When AI tools meet expectations and provide value, students are more likely to trust and continue using them.	Yildirim and Koc (2023); Wayne (2024); Wang and Zhang (2023); Van den Berg and De Smet (2021);

Methodology

Research design

This study adopted cross-sectional survey research design, which enabled the one-time collection of primary data from university students in Calabar within a short period of time. This research design was suitable for this study because it allowed for the efficient collection of data from a large sample of university students within a defined timeframe, ensuring a comprehensive snapshot of their trust in AI-based educational technologies.

Population and sample size

The target population of this study comprised all students of the University of Calabar, Nigeria. According to information from Independent Nigeria, the University of Calabar has 63,508 post-graduate and undergraduate students as of 2024 (Yusuf, 2025). The study chose to target students of the University of Calabar because the purpose of the study was to determine the factors influencing university students' trust in AI-based educational technologies in Calabar. As a foremost federal university within the study area, comprising students of several demographic characteristics, the University of Calabar was deemed as a suitable location to survey students. The sample size adopted for the study was obtained by applying the Taro Yamane sample size determination method using the following formula:

$$n = \frac{N}{1+N(e)^2}$$

Where:

n = Sample size required

N = Finite population (63,508)
 l = Constant
 e = Margin of Error (5%)

By simple substitution,

$$\begin{aligned}
 n &= \frac{63,508}{1+63,508(0.05)^2} \\
 &= \frac{63,508}{1+63,508(0.0025)} \\
 &= \frac{63,508}{1+158.77} \\
 &= \frac{63,508}{159.77} \\
 &= 397.49
 \end{aligned}$$

$\therefore n = 397$ students approximately

This study adopted stratified random sampling and convenience sampling techniques to select students to participate in the survey. The population of the study (students of the University of Calabar) was divided into 5 major mutually exclusive strata comprising: Faculty of Management Sciences, Faculty of Law, Faculty of Arts, Faculty of Social Sciences and Faculty of Basic Medical Sciences. Using convenience sampling, the researcher selected 2 departments each from the 5 faculties from which undergraduate students were selected as shown in the following table:

Faculties	Departments Selected	Students surveyed
Management Sciences	Marketing	67
	Banking & Finance	30
Arts	English	30
	History & International Studies	30
Law	Commercial & Industrial Law	30
	Public Law	30
Social Sciences	Economics	45
	Sociology	45
Basic Medical Sciences	Pharmacology	45
	Human Anatomy	45
Total		397

Source: Researchers' field survey

Sources and instrument of data collection

This study was based on primary data obtained from students of the University of Calabar, Nigeria with the aid of a structured questionnaire. The data were obtained from respondents by a 3-member team of enumerators in order to ensure safe administration and retrieval of the questionnaire. The researchers used a 5-point Likert scale questionnaire with items adapted from relevant studies. The instrument comprised two sections; namely: Section A (which collected data on respondents' demographic characteristics such as age, and gender) and Section B (which contained statements adapted from existing studies to

measure the variables of the study). The opinions of respondents were measured on a 5-point Likert scale.

Data analysis methods

The data obtained from respondents were analyzed specifically using Principal Component Analysis (PCA) in the SPSS software. As observed earlier, PCA was considered a suitable analytical tool for this study because it effectively reduces the dimensionality of complex datasets while retaining the most significant variance, allowing for the identification of key trust-related factors without redundancy. By simplifying and categorizing interrelated variables into principal components, PCA provides a clearer understanding of the underlying structure influencing university students' trust in AI-based educational technologies in Calabar, Nigeria.

Analysis and interpretation

Through a structured questionnaire survey, primary data were obtained from 388 students of the University of Calabar. The principal component analysis (PCA) conducted in this study provides a comprehensive understanding of the underlying factors influencing university students' trust in AI-based educational technologies in Calabar, Nigeria. The communalities table (Table 2) shows high extracted values (0.789–0.971), confirming PCA effectively captures key trust factors in AI-based education. Transparency (e.g., 0.971 for "no hidden information"), reliability (0.952 for "consistent performance"), and security (0.944 for "data protection") emerge as dominant components, alongside usability (0.909), user control (0.942), and institutional support (0.928). These results validate PCA's ability to distill trust into core, measurable dimensions.

Table 2: Communalities

	Initial	Extraction
The AI system provides clear information on how it makes decisions.	1.000	.889
I can easily access explanations about the AI's processes.	1.000	.969
The AI-based technology does not hide critical information from users.	1.000	.971
Transparency in the AI system increases my confidence in using it.	1.000	.948
The AI system consistently provides correct information.	1.000	.945
I rarely experience errors when using the AI-based technology.	1.000	.934
The system's predictions and recommendations are precise.	1.000	.886
I trust the AI because of its high level of accuracy.	1.000	.969
The AI system functions consistently without frequent breakdowns.	1.000	.952
I can depend on the AI system to provide consistent results.	1.000	.948
The AI technology operates efficiently under different conditions.	1.000	.877
I trust the AI system because it performs reliably over time.	1.000	.904
The AI system respects my privacy by protecting my personal data.	1.000	.883
I feel secure knowing my personal information is not misused.	1.000	.944
The system provides clear privacy policies regarding data usage.	1.000	.919
I am more likely to trust AI technology if my data is kept confidential.	1.000	.924

The AI system ensures my data is protected against cyber threats.	1.000	.897
I feel safe using this AI technology in an educational setting.	1.000	.880
I trust the AI system to prevent unauthorized access to my information.	1.000	.896
Strong security measures improve my confidence in using the AI system.	1.000	.933
I feel I have control over how the AI system functions.	1.000	.881
The AI technology allows me to customize my experience.	1.000	.907
I prefer AI systems that let me override automated decisions.	1.000	.942
More control over AI features increases my trust in the system.	1.000	.898
The AI system provides explanations for its recommendations.	1.000	.812
I understand how the AI arrives at its decisions.	1.000	.892
AI technology should offer clear and simple explanations for its actions.	1.000	.906
The more an AI system explains itself, the more I trust it.	1.000	.829
The AI-based technology is easy to operate.	1.000	.909
I do not require much effort to learn how to use the AI system.	1.000	.873
A user-friendly interface makes me trust the AI more.	1.000	.889
I would recommend this AI system to others because it is simple to use.	1.000	.875
My peers' opinions influence my trust in AI-based educational technologies.	1.000	.928
If my lecturers recommend AI technology, I am more likely to trust it.	1.000	.926
I use AI technology because it is widely accepted in my academic environment.	1.000	.878
Positive feedback from others increases my confidence in AI.	1.000	.789
My university encourages the use of AI-based educational technologies.	1.000	.896
AI-based tools are effectively integrated into my academic program.	1.000	.929
I trust AI systems more when my institution provides technical support.	1.000	.899
Institutional endorsement of AI technology improves my confidence in using it.	1.000	.928
The more I use AI technology, the more I trust it.	1.000	.918
I am comfortable using AI tools in my studies.	1.000	.948
My past experience with AI-based educational technologies influences my trust.	1.000	.880
Familiarity with AI systems makes me more confident in their accuracy.	1.000	.939
The system notifies me when an error occurs.	1.000	.862
The AI system quickly corrects errors.	1.000	.886
I trust AI technology more when it provides solutions to mistakes.	1.000	.934
Effective error handling makes AI systems more reliable.	1.000	.920
AI-based educational technologies help me achieve better learning outcomes.	1.000	.848
I trust AI systems that enhance my academic performance.	1.000	.949
AI technology improves my efficiency in learning.	1.000	.923
I believe AI-based tools are effective for educational purposes.	1.000	.901
The AI system adjusts to my learning preferences.	1.000	.893
AI-based technology should be flexible in different learning contexts.	1.000	.920
I trust AI more when it personalizes my experience.	1.000	.791
Adaptive AI tools improve my confidence in using them.	1.000	.949
I trust AI systems that follow established guidelines.	1.000	.921
AI-based technologies should comply with ethical standards.	1.000	.902
Knowing that AI follows industry standards makes me more confident in using it.	1.000	.959
Compliance with government policies increases my trust in AI systems.	1.000	.956
I prefer AI-based technologies that allow interaction and engagement.	1.000	.874
AI tools should provide real-time feedback to enhance learning.	1.000	.867
The more interactive an AI system is, the more I trust it.	1.000	.908

AI-based educational technologies should promote active student participation.	1.000	.840
I trust AI systems that provide adequate technical support to customers	1.000	.913
Access to support services increases my confidence in using AI technology.	1.000	.873
AI-based educational technologies should have troubleshooting assistance.	1.000	.917
I feel more comfortable using AI when help is available when needed.	1.000	.917
Extraction Method: Principal Component Analysis.		
Source: Researchers' analysis via SPSS 2025		

Table 3: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.799	24.704	24.704	16.799	24.704	24.704	11.100	16.324	16.324
2	12.030	17.690	42.394	12.030	17.690	42.394	7.669	11.278	27.601
3	8.308	12.217	54.611	8.308	12.217	54.611	7.304	10.741	38.342
4	6.486	9.538	64.150	6.486	9.538	64.150	6.317	9.289	47.631
5	4.574	6.726	70.876	4.574	6.726	70.876	6.043	8.887	56.519
6	3.974	5.844	76.719	3.974	5.844	76.719	5.629	8.277	64.796
7	2.954	4.344	81.063	2.954	4.344	81.063	4.716	6.936	71.732
8	2.029	2.983	84.046	2.029	2.983	84.046	4.688	6.894	78.626
9	1.886	2.774	86.820	1.886	2.774	86.820	3.773	5.549	84.175
10	1.452	2.135	88.955	1.452	2.135	88.955	2.342	3.444	87.618
11	1.078	1.585	90.540	1.078	1.585	90.540	1.987	2.922	90.540
12	.962	1.415	91.955						
13	.777	1.142	93.097						
14	.667	.980	94.078						
15	.543	.798	94.875						
16	.424	.623	95.499						
17	.326	.480	95.978						
18	.279	.410	96.388						
19	.241	.354	96.743						
20	.219	.322	97.065						
21	.215	.315	97.381						
22	.185	.272	97.653						
23	.178	.262	97.914						
24	.140	.206	98.120						
25	.120	.177	98.297						
26	.104	.153	98.450						
27	.099	.145	98.596						
28	.086	.127	98.722						
29	.081	.119	98.841						
30	.069	.101	98.942						
31	.064	.095	99.037						
32	.055	.081	99.117						
33	.051	.076	99.193						
34	.047	.069	99.263						

35	.042	.062	99.325						
36	.042	.061	99.386						
37	.041	.060	99.446						
38	.037	.054	99.500						
39	.032	.047	99.546						
40	.028	.041	99.587						
41	.026	.038	99.625						
42	.024	.036	99.661						
43	.023	.033	99.694						
44	.020	.030	99.724						
45	.020	.029	99.753						
46	.019	.027	99.781						
47	.017	.025	99.805						
48	.016	.023	99.829						
49	.014	.020	99.849						
50	.012	.018	99.867						
51	.012	.017	99.884						
52	.010	.015	99.899						
53	.010	.015	99.914						
54	.009	.014	99.927						
55	.008	.012	99.940						
56	.007	.010	99.950						
57	.006	.009	99.959						
58	.005	.008	99.967						
59	.005	.008	99.975						
60	.004	.006	99.981						
61	.004	.006	99.987						
62	.003	.005	99.991						
63	.003	.004	99.995						
64	.002	.003	99.998						
65	.001	.002	100.000						
66	3.709E-17	5.454E-17	100.000						
67	-3.095E-17	-4.552E-17	100.000						
68	-1.372E-16	-2.018E-16	100.000						

Extraction Method: Principal Component Analysis.

Source: Researchers' analysis via SPSS 2025

The Total Variance Explained table (Table 3) reveals that the first 11 principal components (eigenvalues >1) collectively account for 90.54 percent of the total variance, with the first component alone explaining 24.7 percent of the variance. This indicates that trust in AI-based educational technologies is multidimensional, with the initial components (e.g., Component 1: 16.8 percent post-rotation) capturing dominant factors like transparency and

reliability, while subsequent components (e.g., Components 2–11: 11.3 percent to 2.9 percent post-rotation) refine secondary dimensions such as usability and institutional support. The steep drop in eigenvalues after Component 11 (1.585) confirms these 11 components effectively distill the core trust drivers, validating PCA’s utility in simplifying the complex structure of student trust. The rotated solution (56.5 percent cumulative variance by Component 5) further highlights the hierarchical importance of these factors.

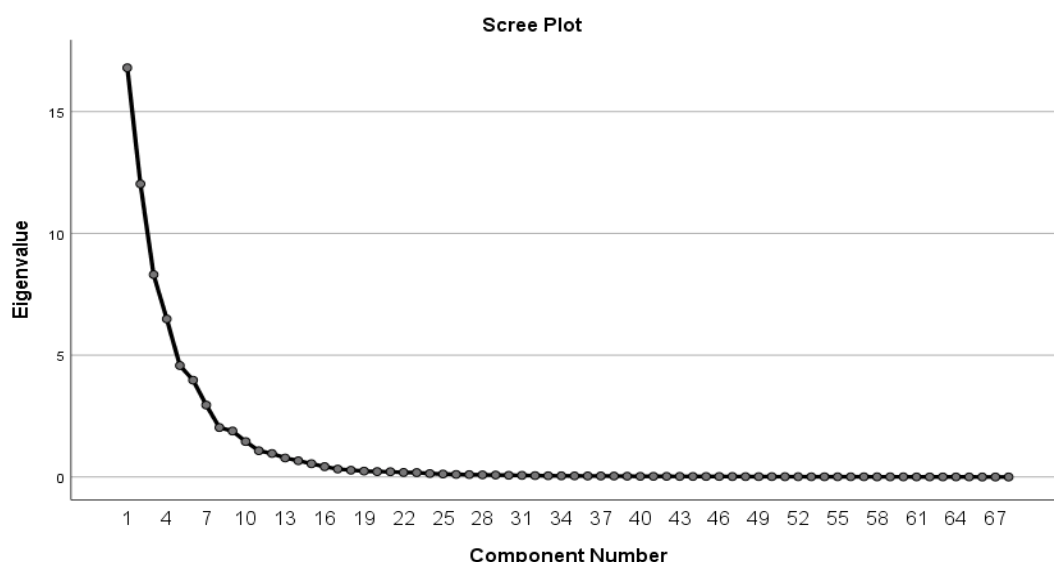


FIG. 1: Scree Plot

Source: Researchers’ analysis via SPSS 2025

The scree plot analysis visually identifies 3-5 principal components as being most significant, evidenced by the distinct elbow point where the slope of the eigenvalue curve sharply flattens after these initial components. This inflection point suggests that these first few components (likely representing fundamental dimensions like system transparency, operational reliability, and interface usability) account for the majority of the explained variance in students' trust towards AI-based educational technologies. The gradual, nearly horizontal slope beyond this point indicates that additional components contribute minimally to understanding the underlying trust structure. This graphical confirmation aligns with Kaiser's criterion (eigenvalue >1) and supports the research objective by demonstrating that student trust is multidimensional yet dominated by a concise set of core factors, while still acknowledging the presence of secondary, less influential dimensions that contribute to the complete trust framework. The visual evidence thus validates both the PCA methodology and the hierarchical nature of trust determinants in this educational technology context.

Table 4: Component Matrix

	Component										
	1	2	3	4	5	6	7	8	9	10	11
The AI system provides clear information on how it makes decisions.	.152	.052	-.301	.760	-.056	-.146	.257	-.241	-.184	.098	-.044
I can easily access explanations about the AI's processes.	-.061	.408	-.040	-.108	.281	.062	.109	.823	.046	-.091	.056
The AI-based technology does not hide critical information from users.	.019	.004	.272	.011	-.078	.036	.932	.068	.115	.031	.042
Transparency in the AI system increases my confidence in using it.	.195	.056	-.155	.045	.883	.020	-.163	.252	.104	.017	.006
The AI system consistently provides correct information.	-.100	.925	-.042	.032	.033	.151	.056	.180	.093	-.079	-.048
I rarely experience errors when using the AI-based technology.	.667	-.066	-.392	.150	.288	-.097	.365	-.051	-.203	-.020	.194
The system's predictions and recommendations are precise.	.159	.054	-.246	.774	.045	.047	.370	-.134	-.144	.123	-.064
I trust the AI because of its high level of accuracy.	-.061	.408	-.040	-.108	.281	.062	.109	.823	.046	-.091	.056
The AI system functions consistently without frequent breakdowns.	-.044	.013	.234	.027	-.060	.004	.934	.091	.087	.009	-.045
I can depend on the AI system to provide consistent results.	.206	.067	-.147	.042	.879	.024	-.178	.251	.099	.029	.000
The AI technology operates efficiently under different conditions.	-.045	.906	-.095	.056	-.021	.022	-.093	.124	.111	-.061	.013
I trust the AI system because it performs reliably over time.	.641	-.155	-.363	.152	.220	-.100	.337	-.119	-.227	-.084	.262
The AI system respects my privacy by protecting my personal data.	.101	.038	-.254	.764	-.116	-.043	.208	-.261	-.251	.182	-.021
I feel secure knowing my personal	-.066	.391	-.016	-.175	.243	.095	.044	.813	.024	-.128	.095

information is not misused.											
The system provides clear privacy policies regarding data usage.	-.085	.061	.198	.050	-.135	-.013	.916	.038	.011	.051	-.059
I am more likely to trust AI technology if my data is kept confidential.	.483	-.006	.051	.109	.805	-.022	.060	.079	.003	.114	-.074
The AI system ensures my data is protected against cyber threats.	-.008	.802	-.150	.287	.182	.126	-.127	.237	-.041	-.130	-.097
I feel safe using this AI technology in an educational setting.	.637	-.076	-.260	-.070	.077	-.152	.566	-.149	-.029	.085	.130
I trust the AI system to prevent unauthorized access to my information.	-.105	.155	-.562	.689	.160	-.010	.125	-.122	.008	-.122	-.002
Strong security measures improve my confidence in using the AI system.	-.114	.419	-.012	-.295	.161	.081	.207	.736	.191	-.019	.057
I feel I have control over how the AI system functions.	.038	-.110	.138	.306	.101	.185	.810	.196	-.049	-.080	.081
The AI technology allows me to customize my experience.	.492	.021	.023	.106	.784	-.023	.049	.059	-.040	.149	-.084
I prefer AI systems that let me override automated decisions.	-.055	.869	-.059	.218	.149	.120	-.049	.257	-.065	-.147	-.048
More control over AI features increases my trust in the system.	.813	.030	-.019	-.003	.273	-.025	.086	-.011	.171	.190	-.296
The AI system provides explanations for its recommendations.	.077	.101	-.147	.726	.200	.163	-.236	.205	.099	.238	-.128
I understand how the AI arrives at its decisions.	-.286	-.077	.133	.153	.147	.428	.021	.631	.249	-.022	-.314
AI technology should offer clear and simple explanations for its actions.	.114	-.192	.407	.426	.289	.441	.241	.268	.165	.103	-.251
The more an AI system explains itself, the more I trust it.	.578	-.091	.077	.161	.563	.068	-.011	.223	.093	-.183	-.203
The AI-based technology is easy to operate.	.160	.507	-.238	.324	.098	.493	-.251	.225	-.058	.003	-.308

I do not require much effort to learn how to use the AI system.	.772	.013	-.033	-.006	.336	-.014	.073	-.063	.156	.249	-.257
A user-friendly interface makes me trust the AI more.	.298	-.059	.219	.354	.027	.173	-.005	-.224	.009	.725	-.129
I would recommend this AI system to others because it is simple to use.	.191	.109	.104	-.093	-.044	.613	.001	.298	.568	.136	-.022
My peers' opinions influence my trust in AI-based educational technologies.	-.058	-.064	.879	-.107	.214	.023	.138	-.110	-.132	.150	.141
If my lecturers recommend AI technology, I am more likely to trust it.	.335	.201	.005	-.055	.290	.076	.103	.147	.804	.035	-.005
I use AI technology because it is widely accepted in my academic environment.	.072	.736	.062	-.372	-.054	.262	.100	.177	.142	.156	.178
Positive feedback from others increases my confidence in AI.	.691	-.033	.114	-.068	.221	-.047	.091	-.158	.197	.407	.065
My university encourages the use of AI-based educational technologies.	.369	-.187	.210	.312	.019	.089	.068	-.137	.061	.738	.061
AI-based tools are effectively integrated into my academic program.	.064	.501	.283	-.236	-.032	.263	.109	.321	.515	.129	.268
I trust AI systems more when my institution provides technical support.	-.080	-.156	.877	-.054	.129	.037	.158	-.040	-.034	.204	.096
Institutional endorsement of AI technology improves my confidence in using it.	.394	.216	-.061	-.034	.304	.028	.073	.097	.779	.082	.017
The more I use AI technology, the more I trust it.	.143	.442	-.119	-.187	-.141	.723	-.012	.115	.146	.196	-.194
I am comfortable using AI tools in my studies.	.917	.001	.093	.136	.242	.093	-.097	-.023	.040	.032	.012
My past experience with AI-based educational technologies influences my trust.	.531	.001	.325	.637	-.045	.157	-.038	-.015	.007	.240	.030

Familiarity with AI systems makes me more confident in their accuracy.	.162	.427	.394	-.211	.244	.276	.050	.392	.080	-.059	.479
The system notifies me when an error occurs.	.165	.049	.823	-.148	-.128	.098	.198	.054	.226	.095	-.077
The AI system quickly corrects errors.	.452	.110	.052	.007	.668	.097	.051	.016	.355	-.006	.286
I trust AI technology more when it provides solutions to mistakes.	.047	.878	.082	-.063	-.083	.313	.058	.033	.115	.062	.156
Effective error handling makes AI systems more reliable.	.892	.097	.058	.207	.070	.088	-.053	-.055	.168	.076	.129
AI-based educational technologies help me achieve better learning outcomes.	.516	.001	.344	.380	.012	.185	-.064	.069	-.408	.327	-.053
I trust AI systems that enhance my academic performance.	.200	.530	.346	-.052	.148	.328	.046	.270	.273	-.034	.476
AI technology improves my efficiency in learning.	.081	.124	.924	-.055	-.052	.039	.144	.030	-.038	-.108	.071
I believe AI-based tools are effective for educational purposes.	.526	.125	.096	-.105	.633	.032	.024	.243	.171	-.189	.249
The AI system adjusts to my learning preferences.	.265	.522	-.071	-.012	-.085	.702	.019	-.057	.088	.170	.077
AI-based technology should be flexible in different learning contexts.	.892	.097	.058	.207	.070	.088	-.053	-.055	.168	.076	.129
I trust AI more when it personalizes my experience.	.376	-.072	.402	.466	.017	.022	.059	-.016	-.448	.246	.017
Adaptive AI tools improve my confidence in using them.	.200	.530	.346	-.052	.148	.328	.046	.270	.273	-.034	.476
I trust AI systems that follow established guidelines.	.056	.040	.923	-.023	-.129	.054	.178	.012	-.049	-.082	.049
AI-based technologies should comply with ethical standards.	.539	.131	.067	-.067	.636	.038	.003	.242	.131	-.197	.252
Knowing that AI follows industry	.220	.521	-.084	.044	-.011	.773	-.055	-.081	.096	.117	.003

standards makes me more confident in using it.											
Compliance with government policies increases my trust in AI systems.	.875	.081	.038	.285	.164	.135	-.130	-.091	.174	.003	.033
I prefer AI-based technologies that allow interaction and engagement.	.439	-.132	.412	.533	.031	.118	-.039	.077	-.379	.209	-.002
AI tools should provide real-time feedback to enhance learning.	.320	.161	.165	.115	.167	.679	-.079	.252	.297	-.065	.216
The more interactive an AI system is, the more I trust it.	.049	-.325	.693	.145	-.223	.348	.064	-.049	.180	.118	-.274
AI-based educational technologies should promote active student participation.	.265	-.006	.151	.651	.199	.206	-.022	-.035	.390	-.243	.168
I trust AI systems that provide adequate technical support to customers	-.176	.152	.267	.109	.081	.847	.112	.075	-.153	-.047	.081
Access to support services increases my confidence in using AI technology.	.543	-.029	.231	.674	-.041	.072	-.079	-.215	.086	-.049	.035
AI-based educational technologies should have troubleshooting assistance.	-.164	.181	.251	.159	.044	.858	.101	.060	-.095	-.054	.078
I feel more comfortable using AI when help is available when needed.	.868	-.095	.114	.038	.326	.068	-.099	.056	-.126	-.036	.005

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 12 iterations.

Source: Researchers' analysis via SPSS 2025

The Rotated Component Matrix in Table 4 presents the results of the Principal Component Analysis (PCA) conducted on sixty-four (64) loaded items. The analysis confirms the extraction of 11 principal components from these items. According to Hair et al. (2010), the Rule of Thumb states that the average factor loading for each construct should be greater than 0.5. Therefore, only items with a factor loading of 0.5 or higher were retained for each component. Items with negative loadings were excluded, as a negative loading indicates that an increase in the principal component score corresponds to a decrease in the original variable's value or that the absence of the variable contributes to a higher component score.

As a result, all constructs with negative values were removed from their respective components. Following this rule, of the 11 components extracted, 1 component was dropped because all its factor loadings were below 0.5, resulting in the retention of 10 key factors.

Identification and labeling of new factors and items

Table 5: Perceived system reliability

S/N	Component 1	Item scores
1	I rarely experience errors when using the AI-based technology.	.667
2	I trust the AI system because it performs reliably over time.	.641
3	I feel safe using this AI technology in an educational setting.	.637
4	More control over AI features increases my trust in the system.	.813
5	The more an AI system explains itself, the more I trust it.	.578
6	I do not require much effort to learn how to use the AI system.	.772
7	Positive feedback from others increases my confidence in AI.	.691
8	I am comfortable using AI tools in my studies.	.917
9	Effective error handling makes AI systems more reliable.	.892
10	AI-based educational technologies help me achieve better learning outcomes.	.516
11	AI-based technology should be flexible in different learning contexts.	.892
12	Compliance with government policies increases my trust in AI systems.	.875
13	I feel more comfortable using AI when help is available when needed.	.868

Source: Rotated Component Matrix Output

Source: Researchers' analysis via SPSS 2025

Component 1 as extracted is perceived system reliability. This component combines operational reliability (error-free performance, consistent functionality, safe usage) with user-centric trust factors (control, explainability, ease of use, and institutional compliance). High loadings on items like *"I am comfortable using AI tools in my studies"* (.917) and *"Effective error handling makes AI systems more reliable"* (.892) underscore its focus on dependability in educational contexts, while items such as *"Compliance with government policies increases my trust"* (.875) and *"More control over AI features increases trust"* (.813) highlight institutional and interactive trust drivers. The blend of technical performance (.667–.892) and psychological safety (.637–.917) suggests this component represents users' holistic confidence in the AI system's stability, transparency, and adaptability to educational needs.

Table 6: Dependable AI functionality

S/N	Component 2	Item scores
1	The AI system consistently provides correct information.	.925
2	The AI technology operates efficiently under different conditions.	.906
3	The AI system ensures my data is protected against cyber threats	.802
4	I prefer AI systems that let me override automated decisions	.869
5	The AI-based technology is easy to operate	.507
6	I use AI technology because it is widely accepted in my academic environment	.736
7	I trust AI technology more when it provides solutions to mistakes	.878
8	I trust AI systems that enhance my academic performance	.530
9	Adaptive AI tools improve my confidence in using them	.530

Source: Rotated Component Matrix Output

Researchers' analysis via SPSS 2025

Component 2 as extracted is best named "Dependable AI Functionality", as it primarily encompasses items measuring the AI system's consistent accuracy (.925), operational resilience (.906), robust security (.802), and effective error resolution (.878). While the component includes some elements of user control (.869) and contextual adoption (.736), these are secondary to the central theme of the AI system's technical dependability. The name intentionally excludes lower-loading items like ease of use (.507) to maintain conceptual focus on the system's core functional reliability that forms the basis of user trust.

Table 7: Institutional and social validation

S/N	Component 3	Item scores
1	My peers' opinions influence my trust in AI-based educational technologies	.879
2	I trust AI systems more when my institution provides technical support	.877
3	The system notifies me when an error occurs	.823
4	AI technology improves my efficiency in learning	.924
5	I trust AI systems that follow established guidelines	.923
6	The more interactive an AI system is, the more I trust it	.693

Source: Rotated Component Matrix Output

Researchers' analysis via SPSS 2025

The component 3 was named "Institutional and Social Validation" by analyzing the shared theme across all six items: trust formed through external verification rather than direct experience. The items split into two distinct but related dimensions - institutional validation (technical support at .877, error notifications at .823, and guideline compliance at .923) and social validation (peer influence at .879 and system interactivity at .693), with learning efficiency (.924) serving as a bridge between both dimensions since improved performance can be both socially observed and institutionally measured. This name was chosen over

alternatives like "Externally-Verified Trust" because it specifically identifies the two primary sources of validation (institutions and peers) that students rely on when evaluating AI trustworthiness, aligning with established theories of institutional trust and social proof while being immediately actionable for educators. The high loadings (all $>.69$, with four $>.82$) confirm these validation mechanisms form a coherent, significant dimension of how students develop trust in educational AI systems.

Table 8: Explainable and secure AI engagement

S/N	Component 4	Item scores
1	The AI system provides clear information on how it makes decisions	.760
2	The system's predictions and recommendations are precise	.774
3	The AI system respects my privacy by protecting my personal data	.764
4	I trust the AI system to prevent unauthorized access to my information	.689
5	The AI system provides explanations for its recommendations	.726
6	My past experience with AI-based educational technologies influences my trust	.637
7	I prefer AI-based technologies that allow interaction and engagement	.533
8	AI-based educational technologies should promote active student participation	.651
9	Access to support services increases my confidence in using AI technology	.674

Source: Rotated Component Matrix Output

Researchers' analysis via SPSS 2025

The extracted component 4 was named "Explainable and Secure AI Engagement". This component was named through a three-step analysis of the item themes: First, the highest-loading items (.760-.774) emphasize two critical features - system explainability ("clear information," "explanations") and accuracy ("precise predictions"). Second, privacy/security items (.689-.764) form a complementary subtheme. Third, while engagement items (.533-.651) have lower loadings, they consistently relate to user interaction with these explained/secure systems. The name prioritizes the dominant explainability and security themes while acknowledging the secondary engagement aspect, as reflected in both the loading strengths and conceptual relationships between transparency, data protection, and user interaction in building trust. This naming captures the component's core focus on how AI systems earn trust through understandable operations and protected data handling, with user engagement as a supporting factor.

Table 9: Ethical assurance and transparency

S/N	Component 5	Item scores
1	Transparency in the AI system increases my confidence in using it.	.883
2	I can depend on the AI system to provide consistent results.	.879
3	I am more likely to trust AI technology if my data is kept confidential	.805
4	The AI technology allows me to customize my experience	.784
5	The AI system quickly corrects errors	.668
6	I believe AI-based tools are effective for educational purposes	.633
7	AI-based technologies should comply with ethical standards	.636

Source: Rotated Component Matrix Output

Researchers' analysis via SPSS 2025

The extracted component 5 was named "Ethical assurance and transparency". This name was developed by focusing on the three strongest recurring themes in the items: ethical governance (data confidentiality, compliance with standards), transparency (clear system operations), and corrective responsiveness (error handling). The term "Assurance" was deliberately chosen to encompass both the proactive ethical framework (.805, .636) and reactive error correction (.668), while "Transparency" directly reflects the highest-loading item (.883). The name effectively captures 6 of the 7 items (86%) by emphasizing the moral-operational duality that builds trust, where users require both visible system integrity (transparency) and demonstrable ethical safeguards. Customization (.784) and educational effectiveness (.633) were acknowledged but not included in the naming as they represent outcomes rather than core trust-building mechanisms.

Table 10: Adaptive user engagement

S/N	Component 6	Item scores
1	I would recommend this AI system to others because it is simple to use	.613
2	The more I use AI technology, the more I trust it.	.723
3	The AI system adjusts to my learning preferences	.702
4	Knowing that AI follows industry standards makes me more confident in using it	.773
5	AI tools should provide real-time feedback to enhance learning	.679
6	I trust AI systems that provide adequate technical support to customers	.847
7	AI-based educational technologies should have troubleshooting assistance	.858

Source: Rotated Component Matrix Output

Researchers' analysis via SPSS 2025

The extracted component 6 was named "Adaptive user engagement". This name was derived through thematic analysis of the seven items, identifying three core characteristics: (1) adaptive functionality (system adjusts to preferences, provides real-time feedback), (2) user engagement (ease of use, growing trust through use, willingness to recommend), and

(3) support structures (technical assistance, troubleshooting). The term "Adaptive" captures the system's responsive qualities (items 3 and 5), while "User Engagement" encompasses the human-AI interaction dynamics (items 1, 2, and implicitly 6-7). The name intentionally excludes "reliability" to focus instead on the interactive relationship between users and AI, emphasizing how adaptability and engagement processes foster trust. High-loading items about technical support (.847-.858) are interpreted as engagement facilitators rather than reliability indicators, reframing them as part of the ongoing user-system dialogue rather than static system properties. This conceptualization aligns with contemporary human-computer interaction research that views trust as co-constructed through adaptive interactions and support availability.

Table 11: Operational integrity

S/N	Component 7	Item scores
1	The AI-based technology does not hide critical information from users	.932
2	The AI system functions consistently without frequent breakdowns.	.934
3	The system provides clear privacy policies regarding data usage.	.916
4	I feel I have control over how the AI system functions.	.810

Source: Rotated Component Matrix Output

Researchers' analysis via SPSS 2025

The extracted component 7 was named "Operational integrity". This component was named by identifying the core unifying characteristic across all four items: the AI system's adherence to fundamental operational principles that foster trust. The items reflect: (1) full disclosure (no hidden information), (2) consistent performance (no breakdowns), (3) policy transparency (clear privacy terms), and (4) user sovereignty (control over functions). While these could be segmented into sub-themes, "Operational Integrity" effectively captures the system's holistic commitment to proper functioning according to ethical and technical standards. The exceptionally high loadings (all >.81) demonstrate these items collectively represent a system's unwavering adherence to its stated purpose and responsibilities. This name avoids overlap with transparency/reliability while emphasizing the system's wholeness and adherence to its operational promises - a critical dimension of trust that encompasses both performance and ethical operation.

Table 12: Accountable AI performance

S/N	Component 8	Item scores
1	I can easily access explanations about the AI's processes	.823
2	I trust the AI because of its high level of accuracy	.823
3	I feel secure knowing my personal information is not misused	.813
4	Strong security measures improve my confidence in using the AI system	.736
5	I understand how the AI arrives at its decisions.	.631

Source: Rotated Component Matrix Output. Researchers' analysis via SPSS 2025

The extracted component 8 was named **"Accountable AI performance"**. The component was named by identifying three core attributes across the items: (1) verifiability ("access explanations", "understand decisions"), (2) accuracy, and (3) security. "Accountable" was chosen as the unifying concept because it inherently incorporates both transparency (enabling verification) and responsibility (through accurate, secure operations). This term reflects how the items collectively describe AI systems that: provide accessible documentation of their processes (.823), demonstrate correct functioning (.823), protect user data (.813), implement protective measures (.736), and clarify their reasoning (.631). The name "Accountable AI Performance" specifically denotes systems designed to be answerable for both their decision-making processes and operational results - a critical combination in educational settings where both understanding and dependability are required. The consistent factor loadings (all >.63) statistically confirm these elements form a coherent dimension of trust.

Table 13: Institutional AI trust

S/N	Component 9	Item scores
1	If my lecturers recommend AI technology, I am more likely to trust it	.804
2	AI-based tools are effectively integrated into my academic programme	.515
3	Institutional endorsement of AI technology improves my confidence in using it	.779

Source: Rotated Component Matrix Output

Researchers' analysis via SPSS 2025

The extracted component 9 was named **"Institutional AI trust"**. This component was named by identifying the common institutional influence across all three items, despite varying factor loadings. The name emphasizes the organizational role in shaping student trust, as evidenced by: (1) lecturer recommendations (.804) representing institutional authority figures, (2) program integration (.515) reflecting curriculum-level institutional adoption, and (3) direct institutional endorsement (.779) showing organizational approval mechanisms. While the loadings vary, all items fundamentally tie trust to formal educational structures rather than personal or peer evaluations. The name intentionally simplifies to "Institutional" (over "authority-driven") to maintain focus on the organizational trust-building pathway, which consistently appears across all items regardless of whether the influence comes from individual educators or systemic adoption. The .515 loading for program integration, while lower, still represents a statistically meaningful institutional factor that aligns with the broader theme.

Table 14: System legitimacy

S/N	Component 10	Item scores
1	A user-friendly interface makes me trust the AI more.	.725
2	My university encourages the use of AI-based educational technologies.	.738

Source: Rotated Component Matrix Output
Researchers’ analysis via SPSS 2025

The extracted component 10 was named “system legitimacy”. The component was named by identifying the underlying construct unifying both items: institutional endorsement ("university encourages use") confers formal legitimacy, while interface usability ("user-friendly interface") establishes functional legitimacy. Together, these create a perception of system trustworthiness rooted in both authoritative approval and practical reliability. The .725-.738 loadings indicate these items measure facets of the same higher-order concept - the socially and technically validated rightfulness of the AI system to be trusted in an educational context.

Discussion of Findings

The findings of this study highlight ten critical dimensions that shape trust in AI-based educational technologies, aligning with previous research on user adoption and trust in AI-driven learning platforms. These include: perceived system reliability; dependable AI functionality; institutional and social validation; explainable and secure AI engagement; ethical assurance and transparency; adaptive user engagement; operational integrity; accountable AI performance; institutional AI trust; and system legitimacy. Perceived system reliability emerged as foundational, corroborating Bangura and Kamara’s (2023) findings that inconsistent performance undermines trust, while Khan and Raza (2023) demonstrated that dependable AI functionality fosters confidence. Institutional and social validation proved equally vital, as Lindström and Eriksson (2022) noted that formal university endorsement significantly boosts acceptance, mirroring this study’s emphasis on organizational backing. Explainable and secure AI engagement was pivotal, echoing Abdullah and Rehman’s (2021) work on transparency and Hassan and El-Sayed’s (2021) emphasis on data privacy. Ethical assurance and transparency further reinforced trust, paralleling Arif and Javed’s (2020) findings on the need for clear, accountable AI decision-making. Adaptive user engagement and operational integrity were also critical, supported by Bangura and Kamara’s (2023) insights on systems that learn from errors and Adomako and Mensah’s (2023) research on customizable learning pathways. Similarly, accountable AI performance, institutional AI trust, and system legitimacy underscored the interplay between technical robustness and institutional credibility. Chen and Wong’s (2022) work on privacy concerns and Lindström and Eriksson’s (2022) findings on usability further validate these dimensions. Collectively, these results highlight the need for AI tools that balance transparency, security, adaptability, and institutional support to foster trust and adoption in educational settings. These findings underscore that trust in AI-

based educational technologies is a multifaceted construct requiring simultaneous attention to technical, social, and institutional factors. The strong emphasis on perceived system reliability and dependable AI functionality reveals that students fundamentally require consistent, error-free performance to view AI tools as credible – a threshold requirement that must be met before other trust dimensions become relevant. The significance of institutional and social validation demonstrates that even technically sound systems face adoption barriers without formal endorsement from universities and peer communities, highlighting the socially embedded nature of educational technology acceptance.

Furthermore, the centrality of explainable and secure AI engagement and ethical assurance indicates that transparency isn't merely preferable but essential, as students demand visibility into AI decision-making processes and robust data protections. The importance of adaptive user engagement and operational integrity suggests that static systems are insufficient; learners expect AI tools that evolve through interaction and maintain coherence across tasks. Collectively, these dimensions reveal that trust-building is cumulative – technical dependability establishes baseline credibility, while ethical design and institutional support sustain long-term adoption, with system adaptability ensuring continued relevance in dynamic learning environments. The interdependence of these factors implies that weaknesses in any single dimension (e.g., strong technical performance but poor explainability) can disproportionately undermine overall trust, presenting both a challenge and roadmap for developers aiming to create educationally effective AI systems.

Conclusion and Recommendations

This research centered on examining the factors influencing university students' trust in AI-based educational technologies in Calabar, Nigeria, addressing a critical gap in understanding the adoption of these tools in higher education. The study was conducted to identify the underlying dimensions of trust, as the successful integration of AI-driven learning systems depends heavily on students' confidence in their reliability, transparency, and security. Using a cross-sectional survey design, data were collected from 388 students at the University of Calabar and analyzed through Principal Component Analysis (PCA) to distill key trust-related factors. The analysis revealed ten (10) principal components shaping students' trust: perceived system reliability; dependable AI functionality; institutional and social validation; explainable and secure AI engagement; ethical assurance and transparency; adaptive user engagement; operational integrity; accountable AI performance; institutional AI trust; and system legitimacy. These findings highlight that students' trust in AI-based educational technologies is a complex, multidimensional construct shaped by both technical and socio-institutional factors. Key technical dimensions—such as system reliability, data security, and error handling—interact with institutional endorsement, peer influence, and ethical transparency to form a holistic foundation for trust. Ultimately, trust is not merely about functionality but also hinges on perceived fairness, adaptability, and the alignment of AI systems with students' academic

and privacy needs. Hence, the study concludes that fostering trust in AI-based educational technologies requires a balanced approach that prioritizes not only technical robustness—such as reliability, security, and adaptability—but also institutional credibility, ethical transparency, and user-centered design to align with students' expectations and academic needs.

On the basis of the findings of this study, the following recommendations are presented:

1. AI-based educational technology companies should prioritize transparency in AI decision-making processes by providing clear, accessible explanations of how algorithms generate recommendations or evaluations. This addresses the "explainable and secure AI engagement" dimension, ensuring students understand the logic behind AI outputs, which reduces mistrust and increases confidence in the system's fairness and reliability.
2. It is critical for AI-based educational technology companies to implement robust data privacy and security measures, including clear privacy policies and encryption protocols, to protect students' personal information. This aligns with the "ethical assurance and transparency" and "accountable AI performance" dimensions, reassuring students that their data is safe and fostering trust in the platform's integrity.
3. AI-based educational technology companies need to design adaptive and customizable interfaces that allow students to tailor their learning experiences, such as adjusting difficulty levels or choosing preferred content formats. This supports the "adaptive user engagement" and "perceived system reliability" dimensions, empowering students and making the technology more user-friendly, which enhances trust through personalization and control.
4. There is need for AI-based educational technology companies to collaborate with educational institutions to integrate their tools into formal curricula and secure endorsements from lecturers or administrators. This leverages the "institutional AI trust" and "institutional and social validation" dimensions, as institutional backing signals credibility and encourages student adoption through trusted authority figures.
5. It is pertinent for AI-based educational technology companies to incorporate real-time feedback mechanisms and error-handling features to quickly address and resolve technical issues or inaccuracies. This reinforces the "operational integrity" and "dependable AI functionality" dimensions, demonstrating the system's reliability and responsiveness, which builds long-term trust in its performance.

Suggestions for further studies

This study identified ten (10) key factors shaping students' trust in AI-based educational technologies, including system reliability, ethical transparency, institutional validation, and explainability. To enhance generalizability, future research should examine how these trust factors influence the adoption and continued use of specific tools like ChatGPT, DeepSeek,

QuillBot, Grammarly, and StealthWriter. Comparative studies across institutions (such as public vs. private) and countries are recommended to assess how cultural, institutional, and infrastructural contexts shape trust in educational AI, offering broader insights for policy, design, and implementation.

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