

A Systematic Review Of Student Data Privacy In Web-Based Lecture Delivery Module In Tertiary Institutions In Kogi State Central

Yunisa Sunday¹, Emmanuel Eturpa Salami², Ekundayo Onimisi Kayode³,
Yahaya Yusuf Nurudeen⁴, Joshua Attah⁵

^{1, 2, 3}Dept of Computer Science

^{4, 5}Dept of Software Engineering

^{1, 2, 3, 4, 5}Confluence University of Science and Technology,
Osara Kogi State

Abstract- *With the growing reliance on web-based delivery platforms in tertiary education, concerns around student data privacy have become increasingly prominent. This study presents a systematic review of literature related to data privacy in educational technology, with a focus on tertiary institutions in Kogi Central, Nigeria. The review investigates institutional practices, technological safeguards, legal frameworks, and student perceptions concerning data privacy. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, a total of 47 peer-reviewed studies published between 2021 and 2024 were analyzed. The study critically examine the existing literature on the security of online lecture delivery systems, encryption and blockchain techniques. The review helps to unveil the strengths, weaknesses, and its applications through an indepth review that focused on integrating strong encryption techniques and blockchain schemes. The impact of providing a robust privacy and security framework for a web-based lectures delivery system as well as the challenges and limitations of implementing these technologies in tertiary institutions in Kogi Central, including infrastructure, expertise, and regulatory compliance. The findings reveal significant gaps in policy enforcement, technical implementation, and awareness among stakeholders. This study recommends the adoption of context-specific privacy policies, enhanced cybersecurity protocols, and compulsory privacy education for institutional users.*

Keywords- Data privacy, web-based modules, tertiary institutions, systematic review, Kogi Central, PRISMA, educational technology

I. INTRODUCTION

The integration of web-based delivery modules (WBDMs) such as Learning Management Systems (LMSs), cloud-based educational tools, and virtual learning environments (VLEs) into higher education has accelerated across Nigeria, especially in response to disruptions such as

the COVID-19 pandemic [1]. While these platforms offer flexibility and scalability in academic instruction, they also expose sensitive student data to potential misuse. In the Nigerian context, particularly in Kogi Central, the widespread adoption of WBDMs has not been matched by equivalent progress in data privacy governance and cybersecurity practices. [2] investigate the effects of online lecture quality and academic self-efficacy on the lecture satisfaction in tertiary institutions and subsequently analyzed the use of software application like Social Science Statistics Package (SPSS) to harness the valuable data such as students' data and lecture materials, but this is vulnerable to attacks. It is undeniable that advances in technology and the rapid spread of information are also accompanied by an increase of crime in the IT field; very valuable information is sought by criminals in the IT field in order to be misused so that they gain enormous profit.

The primary aim of this systematic review is to investigate how student data privacy is conceptualized, implemented, and regulated in the deployment of web-based delivery modules in tertiary institutions located in Nigeria and Kogi Central. And to also identify the major student data privacy concerns associated with web-based educational platforms. The objectives are to examine institutional strategies and regulatory compliance mechanisms for data protection. Assess the level of awareness among students and staff regarding data privacy in WBDMs. And provide context-sensitive recommendations for improving data privacy protections.

II. REVIEW OF RELATED WORKS

[17] discuss the benefit of the Internet, online education has rapidly increased over a decade. However, the online learning systems in universities still have some problems, such as the quality of teaching resources are monotonous and uneven, lack of sharing and insufficient education evaluation standards. Therefore, it is difficult to

motivate students to sustain their interest in learning, leaving educators with little confidence on online education. Blockchain technology offers a secure and decentralized solution for managing student data, providing: - Immutable and tamper-proof data storage, transparent and auditable data management, secure authentication and access control mechanisms, decentralized data storage and management. By applying blockchain technology to online lecture delivery systems, educational institutions in Kogi Central can Protect student data from cyber threats and unauthorized access, ensure the integrity, confidentiality, and authenticity of student data, create a secure and trustworthy online learning environment and finally, enhances student data privacy and security of lecture modules in online lecture delivery system in tertiary institution in Kogi Central. This research work on students' data privacy and blockchain scheme for online lecture delivery in tertiary institution in Kogi Central will defeat the problem of the exiting encryption with low computational resources with a new novel approach that can be used to improve the security in online lecture delivery and the security of lecture module on the internet. The whole idea behind this research is to use encryption as an underlying (conveniently available) measure for making data unintelligible, while exploiting fragmentation as a way to break sensitive associations between information.[18] vividly discusses the important of blockchain technology in advancing educational institutions to constantly improve its system through innovations such as cloud Computing, online lecture delivery and online transactions. One of the recent advancements according to AI [18] is the utilization of blockchain technology, which is a system of documentation that is said to have revolutionized the way higher education institutions empower their students, educators, and employers to effectively manage and store information about their students` and lecture modules on internet-based platform for smooth lecturer delivery. Blockchain can also enable secure and verifiable sharing of student data between institutions, which can enhance academic mobility and reduce administrative burdens for both students and institutions. Furthermore, [19] discuss data storage service as one of the main services provided by the cloud provider with the application of Cryptographic techniques in cloud environment where sensitive data are store and preserved. Cryptography is an essential tool that helps to assure our data accuracy. Cryptographic methods have been effectively led by the development of cloud computing and decentralized blockchain scheme where data are stored in distributed ledger techniques.[18] further states that, security and privacy properties like confidentiality, integrity, reliability can be achieved by strong encryption techniques that can securely share with the authorized users by adopting the encryption schemes. [19] also gives detail analysis about the flexibility of

data stored in a web- based internet devises which helps users like students or lecturers or instructors to quickly access the resources efficiently from the third-party service provider to expand the accessibility from different network connection. [19] re- emphasized the benefit of internet-based storage system which stores large amount of data in its storage server in decentralized manner in order to solve the problem of single point of data storage which is vulnerable to attacks and also information leakages. If student's data is stored for a long term over the internet, it does not protect, the data confidentiality will be lost and this makes the hackers to steal the data provided in the storage system and even when data are forwarded to blockchain environment, when this occurs, makes data to lack integrity and the cloud user will be unsatisfied. [18] in their final submission, highlight different encryption techniques that can be used to protect the cloud storage environment where sensitive data are stored and retrieve with control measure. [20] look at Several encryption algorithms that are available are used in information security. These algorithms according to [20] can be categorized as classical encryptions and these encryption algorithms are based on two general principles namely substitution cipher, in which each element in the plaintext is mapped into another element, and transposition cipher, in which elements in the plaintext are rearranged.

The research work by [3] presents a novel framework for classifying secret keys in symmetric encryption algorithms by applying deep transfer learning technique. It addresses the problem of security vulnerabilities which arise from side-channel attacks that exploit leaked electromagnetic signals from cryptographic devices. Traditional attacks depend on exhaustive key-guessing, which is computationally expensive. The method proposed by[3] uses a divide-and-conquer strategy, breaking down long encryption keys into semi-byte units and using a deep residual convolutional neural network for classification. Transfer learning optimizes model training and improves the efficiency; it also reduces the key search space while maintaining very high accuracy. The results show an attack accuracy of up to 91%, demonstrating the effectiveness of the framework in extracting encryption keys from leaked signals with limited data.

[4] presents an improved approach for accelerating RSA key generation by improving the process of finding large prime numbers. Since RSA encryption relies on generating large prime numbers, the proposed method by the researchers incorporates efficient prescreening techniques and Fermat's Little Theorem to reduce the computational complexity. By applying the new approach, the outcome of the study revealed a significant reduction in key generation time, achieving a 66.8% speed increase for 2048-bit keys compared to

conventional methods. The study was able to enhance the overall efficiency of RSA cryptography, making it more practical for real-time applications by refining the process of prime selection and testing.

Privacy-Preserving Techniques for Database System

[5] proposes a new Lightweight Blockchain-based Homomorphic Integrity and Authentication Scheme to improve authentication, content integrity, and privacy in information centric networking. Conventional cryptographic methods in information centric networking face security concerns and computational overhead, especially when there is dependence on decryption for verification. To overcome these concerns, [5] suggested the combination of decentralized trust mechanisms, homomorphic encryption scheme, and blockchain technology.

In contrast to existing methods such as Named Data Networking, Blockchain-Based Data Authentication and Decentralized public key infrastructure as well as Zero Knowledge Proof, Lightweight Blockchain-based Homomorphic Integrity and Authentication Scheme demonstrates a 25% decrease in registration delay, improved scalability, and better protection against privacy breaches. In Federated Learning, a decentralized method that allows collaborative machine learning while protecting data privacy, [6] investigate privacy-preserving methods, the study examines important techniques such as homomorphic encryption, secure aggregation, differential privacy, and zero-knowledge proofs, and concluded that in order to improve security in Federated Learning (FL) systems, issues like as adversarial weaknesses, communication overhead, and trade-offs in model correctness need to be emphasized. The study emphasizes how crucial it is to strike a balance. [7] also discuss how Rule based expert system includes both conventional techniques, such as database management systems (DBMSs), and artificial intelligence (AI) techniques, such as knowledge-based systems (KBSs) or expert systems (ESs) can effectively aid and effective online lecture delivery with the aid of artificial intelligence techniques in enhances a web-based internet. [7] extensively discuss the DBMSs and how effective it can be used for storing, retrieving and generally manipulating student data and lecture modules.

[21] in their paper examined how communication technologies might improve instructional approaches and student involvement in e-learning, highlighting its transformative potential. It highlights how communication tools affect teamwork and information sharing by classifying them into synchronous (like video conferencing and chat) and asynchronous (like forums and emails) approaches. The study

emphasizes the value of blended learning, which combines in-person and online training to enhance student outcomes. It also looks at connectivism's theoretical foundation, which supports flexible digital learning techniques. Lastly, it offers an action research methodology for assessing and improving online learning environments' communication tools.

Private and public blockchain Techniques

An "Anonymous State Pinning" strategy is put out by [22] to improve the security of private blockchains by thwarting consortium member cooperation. The method preserves anonymity and privacy by "pinning" the state of a private blockchain to a public blockchain, like Ethereum. In contrast to current techniques, it stops transaction rate leakage and enables users to contest faulty pins without disclosing their identities. An estimated \$508 is spent on pinning each year, according to the authors' formal security proof and cost analysis. In order to enhance scalability and lessen Ethereum MainNet congestion, they also present a hierarchical pinning architecture [22].

To improve security and trust in cloud environments, [23] suggest Logchain, a blockchain-based system for immutable log storage. The technology ensures log integrity without depending on a single trusted party by integrating with both public (Ethereum) and private (IBM Blockchain) blockchains. By employing a hierarchical ledger topology, Logchain enhances scalability while lowering computing expenses and blockchain congestion. The study offers a thorough implementation, complete with IBM Blockchain and Ethereum smart contracts, as well as a cost and performance analysis. According to the findings, Logchain efficiently maintains log integrity while maximizing blockchain utilization [23].

Tertiary Institutions Lectures Module Technological Frameworks

According to [24], the study looks at the function of communication tools in e-learning and emphasizes how crucial they are for promoting interaction between instructors and students. In order to improve learning experiences, it makes a distinction between synchronous tools like instant messaging and video conferencing and asynchronous resources like discussion boards and emails. The study talks about how these tools affect student engagement, knowledge sharing, and the efficacy of education. It also looks at blended learning, which combines digital and traditional approaches to maximize learning results. Lastly, the study highlights how improving e-learning environments requires technology breakthroughs and adaptive learning methodologies.

In order to solve infrastructure issues in Nigerian education, the article investigates the creation of a text-based e-learning environment and virtual classroom [25]. It combines synchronous and asynchronous learning strategies to improve didactic and collaborative learning while maintaining accessibility. In order to develop an interactive, economical system, the study uses a hybrid design that makes use of programming tools such as HTML, Visual Basic, and FrontPage Express. For system optimization, Selenium performance testing assesses response time, error rate, CPU consumption, and memory utilization. The study emphasizes how technology may improve education and suggests ways that AI and machine learning might be used to make future advancements.

The study investigates the significance of computer skills in enhancing teaching and learning among lecturers in Open Distance E-Learning (ODEL) institutions [26]. Using a quantitative approach, data was gathered from lecturers at two ODEL institutions in South Africa and Nigeria. Findings reveal that computer skills improve instructional delivery, facilitate communication through digital tools, and support asynchronous and synchronous teaching methods. Additionally, challenges such as inadequate resources, lack of training, and resistance to innovation hinder skill acquisition. The study recommends continuous upskilling and integration of modern technologies for better teaching outcomes.

Introduction to asynchronous

In order to improve student engagement, the study assesses the effects of combining educational activities with video modules in asynchronous learning [27]. It uses a quantitative methodology to gauge student interaction by examining secondary data from a learning management system. According to the results, adding organized in- and post-video activities greatly enhances learning outcomes and engagement. The study emphasizes how important instructor presence, social skills, and cognitive abilities are in creating meaningful student connections. For long-term engagement, it is advised to integrate assessment-based incentives and match learning activities with video content.

Through real-world problem-solving exercises, the study examines how well online problem-based learning (PBL) might increase students' interest in mathematics [28]. It emphasizes how PBL encourages teamwork, critical thinking, and independent study, all of which enhance cognitive and affective engagement. Results show that students who took part in online PBL were more motivated, had better problem-solving abilities, and were happier with their educational journey. However, difficulties were identified, including the

need for digital literacy and loneliness in asynchronous settings. To maximize student involvement in online mathematics instruction, the study suggests combining organized PBL projects with frequent feedback and collaborative tools.

Instructional Design Frameworks

[33] conducted a study to look at the methods, efficacy, and theoretical underpinnings of blended learning in higher education. The study also examines the Constructivist learning theories, and successful tactics like the Rotation Model and Flipped Classroom are highlighted. When compared to traditional approaches, blended learning improves student involvement, contentment, and academic performance, according to the research. Notwithstanding its benefits, issues including the requirement for well-structured instructional design and technological obstacles still exist. To maximize blended learning environments, the study suggests better teacher training and technology integration.

The study examines the characteristics impacting undergraduate agricultural entrepreneurs' acceptance of blended learning using the Technology Acceptance Model (TAM) [29]. Perceived utility and simplicity of use, which are impacted by work relevance, computer literacy, teacher support, and perceived enjoyment, are important adoption predictors. According to the study, there is a significant relationship between the intention to use blended learning and perceived ease of use, which increases adoption rates. Gaps in digital literacy and problems with technological compatibility are obstacles. The results emphasize the necessity of customized blended learning initiatives to promote entrepreneurial education in underdeveloped areas.

Three themes emerge from the study's systematic review of factors influencing math teachers' adoption of blended learning: student engagement and learning outcomes; technological pedagogical content knowledge (TPACK) and instructional design; and teacher preparedness and perceptions [30]. The results show that determining educators' preparedness for blended learning depends heavily on institutional support and professional development for teachers. Learning outcomes are improved and student engagement is increased when digital tools and instructional practices are successfully integrated. But problems like unequal access to resources, shortcomings in teacher preparation, and disparities in digital literacy still exist. In order to maximize blended learning methods in mathematics teaching, the study suggests focused interventions and organized professional development.

[31] conducted a study that investigates gamification and edutainment as cutting-edge teaching strategies that improve learning results and student engagement. While gamification uses game-based components like points, leaderboards, and incentives to strengthen information retention, edutainment incorporates multimedia and interactive content to make learning fun. Results indicate that these methods help students develop their critical thinking, creativity, and problem-solving skills. Digital literacy, technology infrastructure, and the difficulty of creating successful gamified courses are still obstacles, though. The study highlights how these methods could revolutionize education in the future by utilizing AI-powered platforms and adaptive learning.

Blended learning, gamification, adaptive learning technology, multimedia content, and regular feedback are among the beneficial pedagogical tactics for digital learners that are examined in the work done by [32]. While gamification uses interactive components to boost motivation, blended learning improves flexibility and customization. Multimedia content enhances memory and comprehension of difficult concepts, while adaptive learning technologies customize content to meet the needs of each individual. Regular feedback helps students monitor their progress and promotes ongoing learner growth. In order to maximize learning results in various educational contexts, the study emphasizes the necessity of combining a variety of digital tactics.

Data Privacy in Web-Based Learning in Nigeria Universities

The adoption of online learning platforms in Nigerian universities has raised critical concerns regarding data privacy. Although the Nigeria Data Protection Regulation (NDPR) represents a legislative advancement, its inconsistent enforcement and weak institutional implementation impede effective protection of personal data [8]. Public awareness of data rights remains low, and many users consent to data collection without fully understanding implications [8]. Additionally, cybersecurity infrastructure, such as secure cloud storage and encryption, is often inadequate, exposing educational data to breaches [9]. Specifically within Nigerian higher education, research indicates pervasive organisational barriers: outdated infrastructure, weak policies, and poor coordination between IT and academic units hinder data protection. [10] provides an in-depth look of homomorphic encryption, a cryptographic technique which enables computations on encrypted data without the need of decryption. This research work outlines Homomorphic encryption fundamental principles, different types like Fully

Homomorphic Encryption and Partially Homomorphic Encryption and its applications in privacy-preserving computations. [10] explores how homomorphic encryption improves data security in cloud computing, secure multi-party computation, and machine learning while also addressing concerns like computational overhead and noise management. The paper also looks at potential future research directions, emphasizing optimizations to improve homomorphic encryption efficiency and applicability in fields like medical data analysis, financial transactions, and secure outsourcing of computations. In Kogi Central tertiary institutions, these challenges are compounded by limited technical capacity and funding. Many facilities lack formal privacy-by-design principles when selecting EdTech platforms, and administrators often procure third-party systems with inadequate encryption or unclear data handling terms. User training is minimal, and data breach response planning is virtually non-existent, meaning even minor incidents can result in exposure without notification.

Blockchain Technology in E-Learning Delivery in Nigeria

Blockchain has attracted academic interest for verifying credentials, ensuring tamper-proof records, and enhancing trust in online learning systems [11]. In principle, blockchain can secure learner achievement records and academic certificates in ways resistant to forgery or alteration. A study by the [12] identified Scalability and energy consumption as constraint to implementation of Blockchain Technology in education. Popular consensus mechanisms, such as proof-of-work, demand high computational power and energy, raising cost and environmental concerns.

Security vulnerabilities which leads to attacks such as 51% control and eclipse attacks threaten blockchain integrity; loss of private keys can lead to irrecoverable credential loss [13]. Also, Skill gaps and interoperability. There is a shortage of blockchain developers and educators in Nigeria, particularly in less-resourced regions like Kogi Central [14]. Furthermore, integrating blockchain systems with existing institutional databases across institutions remains technically challenging.

Table 1 shows the multiple intersecting challenges when attempting to implement robust data privacy, encryption, or blockchain-based systems faced by tertiary institutions in Kogi Central.

Table 1: limitations of Blockchain integration on Web-Based Learning Platforms

Domain	Key Limitation in Kogi Central
Data Privacy	Weak enforcement of GDPR; user ignorance; poor breach response planning
Encryption	Outdated infrastructure; lack of skills; unreliable power supply
Blockchain	High cost; regulatory confusion; privacy immutability conflict; skills shortage

These challenges that are highlighted in Table 1, are symptomatic of broader national issues: underfunded educational ICT infrastructure, limited professional training, and regulatory gaps that lag technological innovation.

III. METHODOLOGY

The approach taken in this study is based on the PRISMA 2020 framework, which helps ensure that the research is clear, repeatable, and meets scholarly standards [15]. A systematic review was used to gather, assess, and bring together existing research on student data privacy in the context of web-based distance learning in universities. Systematic reviews are useful for combining scattered information and finding areas where more research is needed, especially in new or not-well-studied topics [16]. The review was guided by a structured plan following PRISMA guidelines, which included four steps: finding articles, checking their suitability, deciding if they fit the criteria, and including them in the final analysis. Although the study wasn't registered in PROSPERO because it focuses on education instead of health, the review plan was created and followed the PRISMA-P guidelines. The plan included how to ask the research question, what types of studies to include or exclude, how to search for articles, how to manage the data, and how to evaluate the quality of the studies.

Articles were chosen based on clear rules about what to include and what to exclude to make sure they were relevant and well-researched.

The inclusion criteria required articles to be from peer-reviewed journals, books, or conference papers that

addressed student data privacy, data protection, or digital rights in higher education. They had to specifically mention web-based learning tools like learning management systems, virtual learning environments, or online learning platforms. They also needed to be relevant to Sub-Saharan Africa, with a particular focus on Nigeria or similar digital settings.

The exclusion criteria included articles not written in English, non-academic sources like news articles or opinion pieces, studies without real data or strong theoretical analysis, and those that only looked at primary or secondary education. To find more studies, we checked the references of the selected articles, both going back and forward, which gave us 243 unique articles.

The selection process had three stages. First, titles and abstracts were reviewed by two independent reviewers to check for initial relevance, which led to the exclusion of 123 articles. Next, the remaining 120 articles were fully reviewed to see if they met the criteria, and 59 were excluded because they weren't methodologically sound or weren't relevant to the context. In the end, 47 studies met all the inclusion criteria and were included in the final analysis.

A PRISMA flow diagram (Figure 1) was developed to represent this process visually.

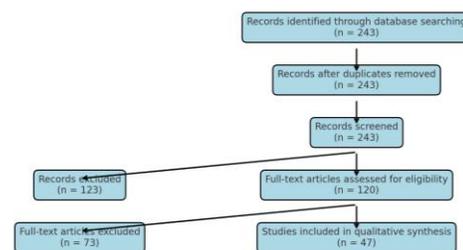


Figure 1: PRISMA Flow Chart Diagram

Data from the included studies were extracted using a structured Excel-based template developed for this review. Quality appraisal was done using The Mixed Methods Appraisal Tool (MMAT) to assess the quality of included studies. This tool supports the evaluation of qualitative, quantitative, and mixed-methods studies using five core criteria for each design type and only studies rated as “moderate” to “high” quality were retained. The quality rating process was independently conducted by two reviewers and discrepancies were resolved through discussion and consensus.

A narrative synthesis approach was also adopted due to the heterogeneity in study designs, contexts, and outcomes. Thematic analysis was conducted to identify recurrent patterns and conceptual categories related to student data privacy. The synthesis followed five stages: Data Familiarization, Initial Coding, Thematic Mapping, Interpretation and Quantitative summaries, such as frequency counts and study distributions, were also included to support the thematic interpretations.

IV. DISCUSSION

The findings from the reviewed works clearly showed that several systemic and technical obstacles are reason hindering the deployment of blockchain in tertiary education. While some institutions lack understanding of its broader use cases, the High costs infrastructure dependency and deployment of even permissioned or private blockchain networks makes it difficult for most institution because it usually entails significant capital expenditure, continuous maintenance, and reliable power. Most textbooks on cybersecurity lay emphasis on encryption protocols and access controls, the practical implementation in Nigerian tertiary institutions faces severe hurdles. Institutions rely on outdated servers and legacy systems that cannot support modern encryption standards. Funding limitations has also restricted procurement of secure platforms and infrastructure. The skills gap in IT practical adoption among many staff in Nigerian universities often compounded the issue and lack of training in cryptographic tools and key management practices, leading to key-rotation neglect or insecure storage of keys. The problem of intermittent electricity and poor infrastructure further complicate encryption processes; unreliable power supplies force systems offline before encryption modules can authenticate or complete secure data transfers in higher institutions in Kogi Central senatorial district of the state. Regulatory uncertainty and legal compliance as one of the challenges due to the decentralized nature of blockchain complicates compliance with Nigeria's Data Protection Act, particularly regarding data subject rights.

V. CONCLUSION

While data privacy, strong encryption, and blockchain technology hold promise for enhancing the security and trustworthiness of web-based learning, their realization in Nigerian tertiary contexts and particularly in Kogi Central remains severely constrained. Persistent deficiencies in legislative enforcement, infrastructure, technical capacity, and regulatory frameworks undermine effective implementation. To address these limitations, policymakers and educational institutions must: strengthen enforcement of NDPR, invest in ICT infrastructure and staff

training, adopt privacy-by-design frameworks, and develop context-appropriate blockchain pilots (e.g. private or consortium-based systems) aligned with data protection obligations.

Future empirical research should focus specifically on Kogi Central institutions to document institutional readiness, stakeholder perceptions, and pilot implementation outcomes of encryption and blockchain in e-learning environments. And also development of comprehensive framework that will make the adoption of blockchain into teaching and learning.

ACKNOWLEDGEMENT

I wish to acknowledge the contributions of the various co-authors for their immense contributions. I particularly acknowledge and appreciate the Tertiary Education Trust Fund (TETFUND) for providing all the necessary funding expended in conducting this first phase of the research.

DECLARATION OF GENERATIVE ARTIFICIAL INTELLIGENT USAGE

During the preparation of this work the author(s) used Generative AI (ChatGPT-Openai) in order to improve the readability and language only. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article. As a secondary research design, this study did not involve human participants and thus did not require ethical approval. However, all reviewed studies were screened to ensure they had obtained ethical clearance where applicable. The review process adhered strictly to academic integrity, with proper attribution and referencing.

REFERENCES

- [1] Ibrahim A, Uthman R. Digital Transformation in Nigerian Higher education: Challenges and Opportunities. African Journal of Education and Information Technology. 2022;14(3):101–13.
- [2] Ali I, Rafikha A A., Raof P E., Yasmin Y, Syaifuddin M. Data Security Implementation Using Data Encryption Standard Method for Student Values at the Faculty of Medicine. In: Journal of Physics: Conference Series, 5th International Conference on Electronic Design. University of North Sumatra. Published under license: IOP Publishing Ltd; 2020.

- [3] Cui X, Zhang H, Fang X, Wang Y, Wang D, Fan F, et al. A Secret Key Classification Framework of Symmetric Encryption Algorithm Based on Deep Transfer Learning. *Applied Sciences* [Internet]. 2023;13(12025). Available from: <https://doi.org/10.3390/app132112025>
- [4] Ibhharalu F T, Mesioye A E. A Fast Key Generation Algorithm for RSA Crypto System. *Federal University of Agriculture*; 2024.
- [5] Chandra A T, Shivarudraiah R M, Gadde N, Nagarajappa R,K ,B. A Novel Scheme for Enhanced Content integrity, authentication, and Privacy in information-centric Networks Using Lightweight blockchain-based Homomorphic Integrity and Authentication. *International Journal of Electrical and Computer Engineering* [Internet]. 2025;15(1):654–68. Available from: <https://doi.org/10.11591/ijece.v15i1.pp654-668>
- [6] Javed A, Qureshi J N, Khan H, Yousaf H F. An Insightful Machine learning-based privacy-preserving Technique for Federated Learning. *The Asian Bulletin of Big Data Management* [Internet]. 2024;4(4):332–43. Available from: <https://doi.org/10.62019/abbdm.v4i4.277>
- [7] Restackio. Data Privacy Challenges in Nigeria. *Restack*. 2021.
- [8] Adedokun O, Huang X, Kumar R. Evaluating Data Security Measures in AI-Enhanced Educational Tools in Nigerian Universities [Internet]. *International Journal of Applied and Behavioral Science*. *Restackijabs.niilmuniversity.ac.in*. 2022 [cited 2025 Jun 10]. Available from: <https://restackijabs.niilmuniversity.ac.in>
- [9] Yunisa S, Naafisat A, Yahaya Y. A web-based Expert System for Online Medical Diagnoses. *International Organisation of Scientific Research*. 2024;26(4):43–66.
- [10] Eze V H. U. Advanced Cryptographic Protocols Using Homomorphic Encryption. *Research Invention Journal of Engineering and Physical Sciences*. 2024;3(1):80–8.
- [11] Juričić, D. Challenges of Using Blockchain in the Education sector: a Literature Review. *MDPI Applied Sciences*. MDPI. 2021.
- [12] Mohammad A, Vargas S. Barriers Affecting Higher Education Institutions' Adoption of Blockchain technology: a Qualitative Study. *Informatics*. 2022;9(3).
- [13] Disciplines.ng. Role of blockchain in nigerian software engineering [Internet]. *Disciplines*. 2022 [cited 2025 May 21]. Available from: https://discipline.ng/Role_of_blockchain_in_nigerian_software_engineering/
- [14] Firma Law Practice. Examining the Legal Regime of Blockchain and Cryptocurrencies in Nigeria. *Firma Law Practice*. The Firma Law Practice; 2024.
- [15] McKenzie J E, Bossuyt P M, Boutron I, Hoffmann T C, Mulrow CD, Shamseer L, et al. The PRISMA 2020 statement: an Updated Guideline for Reporting Systematic Reviews [Internet]. Vols. 372, n71, <https://www.bmj.com/>. BMJ Publishing Group Ltd; 2021 [cited 2025 May 21]. Available from: <https://doi.org/10.1136/bmj.n71>
- [16] Siddaway A P, Wood A M, Hedges L V. How to Do a Systematic review: a Best Practice Guide for Conducting and Reporting Narrative reviews, meta-analyses, and meta-syntheses. *Annual Review of Psychology* [Internet]. 2019 [cited 2025 May 21];70:747–70. Available from: <https://doi.org/10.1146/annurev-psych-010418-102803>
- [17] Xue L, Fu R, Lin D, Kailan Kuok, Huang C, Su J, et al. Exploring the Innovative Blockchain-Based Application of Online Learning System in University. *Lecture notes in computer science*. 2021 Jan 1;90–101.
- [18] B Al Samarai. IJTPE Journal USE OF BLOCKCHAIN TECHNOLOGY IN EDUCATIONAL FIELD [Internet]. *Researchgate.com*. 2023. Available from: https://www.researchgate.net/publication/377273274_IJTPE_Journal_USE_OF_BLOCKCHAIN_TECHNOLOGY_IN_EDUCATIONAL_FIELD
- [19] Kirubakaramoorthi R, Arivazhagan D, Helen D. Survey on Encryption Techniques Used to Secure Cloud Storage System. *Indian Journal of Science and Technology*. 2015 Dec 17;8(36).
- [20] Sajid F, Hassan MA, Khan AA, Rizwan M, Kryvinska N, Vincent K, et al. Secure and Efficient Data Storage Operations by Using Intelligent Classification Technique and RSA Algorithm in IoT-Based Cloud Computing. *Zakarya M*, editor. *Scientific Programming*. 2022 Apr 14;2022:1–10.
- [21] Zahra O, Amel F N, Mohamed K. Communication Tools and E-Learning: a Revolution in the Research Methodology of Communication for a Pedagogical Scenario. *RA Journal of Applied Research*. 2023;9(4):170–7.
- [22] Robinson P, Brainard J. Anonymous State Pinning for Private Blockchains. *ArXiv (Cornell University)*. Cornell University; 2019.
- [23] Pourmajidi W, Zhang L, Steinbacher J, Miranskyy AV. Immutable Log Storage as a Service on Private and Public Blockchains. *ResearchGate* [Internet]. 2020 Sep 16 [cited 2025 Aug 6]; Available from: https://www.researchgate.net/publication/344276712_Immutable_Log_Storage_as_a_Service_on_Private_and_Public_Blockchains
- [24] Ouariach FZ, Amel N, Mohamed K. Communication Tools between Learning Activities and e-learning [Internet]. *www.atlantispress.com*. Atlantis Press; 2024 [cited 2024 Apr 1]. p. 452–9. Available from:

- <https://www.atlantis-press.com/proceedings/elses-23/125997625>
- [25] Kesiena E, Nwobodo-Nzeribe N H, Chibueze K I. Advancements in E-Learning: Design and Implementation of a Virtual Classroom and Text-Based Environment. ResearchGate [Internet]. 2024 Aug [cited 2025 Aug 6];2(2636 – 590). Available from: https://www.researchgate.net/publication/383344135_Advancements_in_ELearning_Design_and_Implementation_of_a_Virtual_Classroom_and_Text-Based_Environment
- [26] Enakrire Rexwhite Tega . The usefulness of computer skills for enhanced teaching and learning among lecturers in an open distance e-learning (ODEL) environment. Education and Information Technologies. 2024 Feb 13;
- [27] Biswas K, Sridharan B, Javed M. Impacts of Integration of Learning Activities with Video Modules in Asynchronous Learning [Internet]. ResearchGate. unknown; 2023. Available from: https://www.researchgate.net/publication/376686475_Impacts_of_integration_of_learning_activities_with_video_modules_in_asynchronous_learning
- [28] Ellenita G M. Students' Engagement in a Mathematical Investigation through Online Problem-Based Learning. International Journal on Studies in Education. 2023 Dec 28;6(1):51–66.
- [29] Siriwardena BP, Abeywickrama LM, Sandika AL, Vidanapathirana NP. Exposing the Technological Acceptance Model in Blended Learning for Undergraduate Agricultural Entrepreneurs. Journal of the University of Ruhuna. 2024 Dec 31;12(2):70–92.
- [30] Jailani N, Rosli R, Mahmud MS. Factors Influencing Mathematics Teachers' Blended Learning: a Systematic Review. International Journal of Learning, Teaching and Educational Research. 2025 Jan 30;24(1):397–419.
- [31] Neetu Kachhwaha, Islam Magomedov, Aun D. Innovative Educational techniques: Exploring the Potential of Edutainment and Gamification. ITM Web of Conferences [Internet]. 2025 Jan 1;72:05002–2. Available from: https://www.itm-conferences.org/articles/itmconf/abs/2025/03/itmconf_hmmocs-III2024_05002/itmconf_hmmocs-III2024_05002.html
- [32] Duterte J P. Effective Pedagogical Strategies for Digital Learners. EPRA International Journal of Research & Development (IJRD) [Internet]. 2024 Sep 9 [cited 2025 Mar 24];9(9):1–1. Available from: <https://eprajournals.com/IJSR/article/13926>
- [33] Turyamureeba S. Blended Learning in Higher Education: Models and Effectiveness. Eurasian Experiment Journal of Arts and Management [Internet]. 2024 Aug 30 [cited 2025 May 21];5(3):5–10. Available from: https://www.researchgate.net/publication/383544478_Blended_Learning_in_Higher_Education_Models_and_Effectiveness