

Qualitative Study on Integration of Biometric-Based System for Monitoring Students' Lecture Attendance among Higher Institutions in North-Central, Nigeria

OGUNJE, Blessing Fausat¹
ogunjeblessing@gmail.com
08032245618

TUKURA, Charles Saidu¹
tukurasaidu@futminna.edu.ng
09131784058

SOBOWALE, Favour Mosunmola¹
favour.sobowale@futminna.edu.ng
08039657282

DAVID, Michael¹
mikeforheaven@futminna.edu.ng
08033469642

¹Department of Educational Technology, Federal University of Technology, Minna

Abstract

This paper This study investigates integration of Biometric-Based System for monitoring students' lecture attendance among higher institutions in North-Central, Nigeria Information and Communication Technology (ICT) plays a critical role in modern society, revolutionizing various sectors including education. Despite its indispensable nature, traditional attendance methods in Nigerian higher institutions, such as calling names or signing paper registers, are often cumbersome, time-consuming, and prone to issues like signature forgery and inaccurate records, especially in large classes. These inefficiencies contribute to student absenteeism, which has a significant inverse relationship with academic performance. The study BSMSLA aims to address these challenges by automating attendance tracking, enhancing accuracy, promoting student punctuality, and reducing administrative workload for lecturers. This mixed-method study involves developing the BSMSLA package, implementing it in selected institutions, and determining the attitudes and perceptions of both students and lecturers towards its use, as well as its impact on academic performance.

Keywords: Automated Attendance Management System, Information Technology, Nigeria, Performance, Tertiary Institutions

Introduction

Information and Communication Technology (ICT) has profoundly reshaped human activities globally, influencing communication, information access, business, and daily life. Its pervasive impact is evident across various sectors, from social media use for news (69% of U.S. adults) (Pew Research Center, 2021) and widespread internet adoption (over 4.9 billion users worldwide in 2021), to the transformation of e-commerce (USD 4.28 trillion in global sales in 2020) (Statista, 2021). Education, in particular, has been significantly influenced, with online learning becoming crucial during events like the COVID-19 pandemic, affecting over 1.2 billion students globally. Beyond remote learning, ICT, and more specifically Information Technology (IT), plays an indispensable role in enhancing educational standards. IT's role in education includes automating attendance tracking using technologies such as biometric scanners, RFID cards, or mobile apps, thereby eliminating manual processes, reducing errors, and enabling real-time data collection and analysis. This allows institutions to monitor attendance trends, identify chronic absenteeism, and make informed decisions. Integrated IT systems can link attendance data with student information systems, class schedules, and academic records, facilitating a comprehensive view of a student's performance over time. Traditional methods, like roll calls or manual signatures, are time-consuming and inefficient, especially in Nigerian higher institutions with large class sizes. These methods are also susceptible to issues like signature forgery, where absent students are marked present by friends. Such inaccuracies contribute to increased workload for lecturers, who must manually calculate attendance percentages to determine eligibility for final exams. According to Alyahyan and Düşteğör (2020), Student absenteeism is a critical issue that adversely impacts academic performance, often viewed as a sign of poor motivation for

Qualitative Study on Integration of Biometric-Based System for ... Ogunje, B. F., Et. al.
(2025)

learning. It poses a serious challenge to curriculum implementation and the production of high-level manpower in society. Consequently, there is a pressing need for effective management and maintenance of student information, including attendance, which currently presents a huge workload for lecturers. Biometric technology, a subset of IT, offers a promising solution. It is widely employed across various domains for identification and access control, including industries, airports, ATMs, and jail management (Khan & Efthymiou, 2021). Biometric-based attendance systems use unique physical or behavioural characteristics like fingerprints, face recognition, or iris scans to verify identity, thereby solving problems associated with traditional methods. While biometrics offers convenience and security, student attitudes towards such systems can vary, influenced by factors like privacy concerns, technical reliability, trust in the institution, and peer perceptions. This research aims to address the challenges of attendance monitoring in Nigerian higher institutions by developing and implementing a customized Biometric Attendance Monitoring System (BSMSLA). This system is intended to reduce student absenteeism, eliminate "time theft" (fraudulent attendance), and improve academic performance by ensuring accurate and efficient attendance records.

Literature Review

Concept of Information Technology

Information Technology (IT) is fundamental to modern academic sectors, driving advancements in student monitoring and management systems. IT enables online learning and e-learning platforms, making education more dynamic and accessible anywhere, anytime (Rjeib *et al.*, 2018). It also facilitates data analytics for insights into student performance and automates administrative tasks like enrollment and record-keeping, enhancing efficiency. The development of IT has consistently aimed to provide convenience, speed, and streamline work. Managing student information traditionally is cumbersome, prone to errors, and time-consuming. Modern IT solutions, such as smartphone-based applications, offer more efficient ways to store, retrieve, and send student information (Kehtarnavaz *et al.* 2022)..

Attendance Management Systems (AMS)

Attendance capture and recording are crucial for student academic success, as low attendance often leads to underperformance (Ardill, 2024). The increasing number of students necessitates automated attendance systems to replace tedious traditional methods like manual roll calls or paper sheets, which consume valuable class time and are susceptible to errors or loss.

Common methods of attendance tracking include:

- i. Manual attendance: Traditional, paper-based, time-consuming, and prone to errors or loss.
- ii. Roll call software: Digital platforms used by lecturers for attendance, offering features like student lists and report generation, enabling real-time tracking.

Biometric sheets, which consume valuable class time and are susceptible to errors or loss. Common methods of attendance tracking include:

- i. Manual attendance: Traditional, paper-based, time-consuming, and prone to errors or loss.
- ii. Roll call software: Digital platforms used by lecturers for attendance, offering features like student lists and report generation, enabling real-time tracking.
- iii. Biometric attendance system: Utilizes unique physical (fingerprints, facial features, iris scans) or behavioural characteristics for accurate identification and attendance recording. This method is considered more secure and eliminates proxy attendance.
- iv. Radio Frequency Identification (RFID) or smart card systems: Uses ID cards with embedded RFID chips for registration upon swiping or tapping. RFID technology offers advantages like non-contact data reading, reliable data transfer, and low design costs. Combined with fingerprint identification, it can prevent proxy attendance.
- v. Mobile apps: Allows students or faculty to mark attendance via smartphones, syncing data with institutional databases.

Automated attendance systems offer several advantages:

- i. Accuracy and time efficiency: Reduces errors and saves time compared to manual methods.
- ii. Data Analysis: Provides data for identifying attendance patterns, monitoring trends, and assessing impact on academic performance.
- iii. Compliance: Helps institutions adhere to attendance policies and identify students with poor attendance.
- iv. Communication: Can send automated notifications to parents for unexcused absences.
- v. Report Generation: Facilitates creation of attendance reports for administrative, evaluation, or auditing purposes.
- vi. Biometric Technology Biometric technology is primarily used for identification and access control. It involves the examination of unique physical characteristics (face, fingerprints, palm, retina, and iris) or behavioural characteristics

Qualitative Study on Integration of Biometric-Based System for ... Ogunje, B. F., Et. al. (2025)

(Alrawili, 2024) (speech, signature, and keystroke dynamics). The human face is considered a highly important biometric feature for various applications like security systems and credit card verification.

Biometric systems are classified as:

- i. Unimodal systems: Use a single biometric source (face, iris, and fingerprint).
- ii. Multimodal systems: Enhance performance by combining multiple physical characteristics (face and fingerprint), or using multiple sensors, features, or repeated instances of the same biometric. Examples include systems that combine face and fingerprint recognition for continuous learner validation in e-learning or for online examinations.

Impact of Information Technology on Attendance Management System

IT has transformed attendance management, making it more efficient and accurate. Key impacts include:

- i. Automation: Replaces manual roll calls with faster, more accurate digital systems.
- ii. Real-time data: Lecturers and administrators can instantly access up-to-date attendance records.
- iii. Minimized errors: Automated systems reduce discrepancies inherent in manual recording.
- iv. Integration: Seamlessly integrates with student information systems for comprehensive data management.
- v. Parental communication: Enables instant notifications to parents regarding student attendance.
- vi. Reporting and analytics: Facilitates detailed attendance reports and trend analysis for improved attendance rates.
- vii. Early intervention: Helps identify consistent absenteeism patterns, allowing timely support for at-risk students.
- viii. Transparency and accountability: Maintains a clear audit trail for reporting and compliance.
- ix. Accessibility: Cloud-based and mobile apps allow remote access to attendance data.
- x. Resource optimization: Streamlines processes, freeing educators to focus on teaching.

Importance of Students Attendance to Lectures in Tertiary Institutions

Lecture attendance is a policy issue in Nigerian tertiary institutions, often requiring a minimum percentage (75-80%) for exam eligibility. This mandates accurate attendance records. However, manual methods hinder strict policy implementation due to time consumption, impersonation risks, and high student populations. Poor attendance directly correlates with poor academic performance (Joy *et al.*, 2021). Absenteeism is seen as poor motivation for learning, challenging curriculum implementation. While some strategies like roll calls or surprise quizzes are used, they are often time-consuming and inaccurate. Factors contributing to absenteeism include poor student disposition, societal problems (exam malpractice), health issues, boring teaching methods, peer pressure, poverty, and availability of course materials online (Shete, *et al.*, 2018).

Theoretical Framework

This study is guided by three theoretical models:

Technology Acceptance Model (TAM):

Developed to predict technology acceptance, TAM posits that perceived usefulness and perceived ease of use directly influence a user's willingness to adopt a technology. BioTAM, a specific application, examines factors like user interfaces and biometric procedures in determining user intention for biometric systems. For this study, TAM helps understand student and lecturer attitudes towards BSMSLA.

Unified Theory of Acceptance and Use of Technology (UTAUT):

This framework explains technology acceptance and usage. Applied to biometric attendance systems, UTAUT considers: (i) Performance Expectancy: Belief that the system improves task effectiveness (accurate attendance tracking). (ii) Effort Expectancy: Perceived ease of use, advocating for user-friendly interfaces. (iii) Social Influence: Impact of peers and supervisors' opinions on adoption. (iv) Facilitating Conditions: Availability of training, technical support, and resources.

Perceived Risk: Concerns about privacy, security, and reliability, which must be minimized. (v) Behavioral Intention to Use: Willingness to use the technology. (vi) Actual Use Behavior: Monitoring real-world interaction with the system. (vii) Educational Technology Integration Models: While not solely for attendance systems, models like SAMR (Substitution, Augmentation, Modification, and Redefinition) and RAT (Replacement, Amplification, Transformation) provide frameworks for effective technology integration. A less known model, SAMR (Security, Acceptance, Management, Realization), specifically addresses biometric integration by focusing on data protection, user acceptance, logistical management, and exploring the technology's full educational potential.

Research Methodology

This study employed a mixed-method research design to gain a comprehensive understanding of the attendance system development and validate the effectiveness of the biometric-based system. Quantitative Phase; The quantitative phase focused on collecting numerical data to assess the technical performance and efficiency of the BSMSLA. Data was gathered on

Qualitative Study on Integration of Biometric-Based System for ... Ogunje, B. F., Et. al.
(2025)

attendance rates, accuracy of biometric scans, processing speed, and technical issues using surveys, system-generated data logs, and performance metrics. Statistical analysis quantify accuracy, identify attendance patterns, and assess the system's impact on attendance rates. Qualitative Phase; The qualitative phase aims to explore students' experiences, attitudes, and perceptions regarding the BSMSLA. Data will be collected through interviews, focus groups, and open-ended survey questions, providing insights into user experiences, satisfaction, challenges, and suggestions for improvement. Semi-structured interviews and focus group discussions will be conducted with students, lecturers, and administrators. The study's population consist of all students and lecturers in higher institutions in North-Central Nigeria, with a target population of all Federal Universities in this region. A multi-stage sampling technique was used: 300-level mathematics students from each chosen strata. This specific level is chosen because these students are stable and have two years of academic performance records for comparison, while Lecturers handling mathematics for 300-level students who use the package will be targeted for qualitative data.

Research Instruments

Structured Closed-Ended Questionnaire: Titled "Students' Attitude and Perception on the use of Biometric-based System for Monitoring Students' Lecture Attendance (SAPBSMSLA)". Open-Ended Focused Group Interview Protocol: This was used for the qualitative phase to delve deeper into lecturers' attitudes towards BSMSLA. Interviews audio-recorded with participant consent and transcribed immediately.

Validation and Reliability

Validity: Both the questionnaire and interview protocol were validated by subject matter experts in Information and Communication Technology, Educational Technology, and web/software design for clarity, suitability, language, and logical arrangement. Reliability: A pilot study was conducted with 300-level Computer Science students and lecturers (not part of the main sample). The Cronbach Alpha formula was used to determine internal consistency for the questionnaire, which yielded 0.75. For the interview protocol, an inter-rater scale and Cohen's Kappa formula was used to assess agreement in ratings. Data Analysis Data analysis was independently calculated for the quantitative and qualitative phases. Quantitative Data: Analysed using IBM SPSS Statistics software (version 23). Descriptive analyses describe data, understand variable distribution, and provide numerical analysis. Qualitative Data: provide description and content analysis, aiming to add depth to the quantitative findings.

Significance of the study

The development and implementation of the BSMSLA are expected to yield significant benefits across various stakeholders:

For Students:

- i. Accurate and Reliable Records: Offers a more accurate and reliable method of tracking attendance, reducing proxy attendance and manual input errors.
- ii. Punctuality and Responsibility: Encourages regular class attendance and punctuality by tracking presence.
- iii. Real-time Data Access: Students can access their attendance records in real-time to track their own attendance and identify discrepancies.
- iv. Convenience and User-friendliness: Provides quick and hassle-free entry into classrooms, eliminating physical cards or manual sheets.
- v. Improved Engagement: Helps students reflect on attendance habits to improve engagement and participation.
- vi. Support and Interventions: Facilitates timely interventions for students with attendance issues.
- vii. Campus Security: Enhances security by ensuring only authorized students' access specific areas.

For Lecturers:

- i. Automated Attendance Taking: Automates the process, saving time and effort, allowing more focus on teaching and student interaction.
- ii. Reduced Administrative Workload: Traditional manual tracking is burdensome; the biometric system reduces this, freeing time for academic activities.
- iii. Monitoring and Intervention: Enables easy monitoring of attendance patterns and early identification of at-risk students for timely support.
- iv. Insights into Academic Performance: Attendance data can be correlated with academic performance, informing teaching strategies.
- v. Teaching Effectiveness Evaluation: High attendance may indicate engaging lectures, prompting adjustments for low attendance.

Qualitative Study on Integration of Biometric-Based System for ... Ogunje, B. F., Et. al.
(2025)

- vi. Informed Decision-Making: Attendance data assists in making informed decisions about courses and resource allocation.
- vii. Fosters Accountability: Students are aware their attendance is monitored, encouraging regularity.

For Researchers:

- i. Accurate and Reliable Data: Provides high-quality attendance data for research analysis.
- ii. Time Savings: Automates data collection, allowing more time for other research activities.
- iii. Large-scale Data Collection: Facilitates large-scale data collection across multiple classes and courses, enabling robust analysis.
- iv. Enhanced Validity: Helps control for attendance as a confounding variable in studies, improving internal validity.
- v. Longitudinal Studies: Aids in conducting long-term studies on attendance patterns and their impact.
- vi. Correlational Studies: Allows exploration of correlations between attendance rates and other variables like academic performance or engagement.
- vii. Intervention Effectiveness: Provides evidence for the effectiveness of attendance-related interventions.
- viii. Innovative Methodology: Showcases innovative research methodology in educational technology.
- ix. Interdisciplinary Collaboration: Fosters collaboration among researchers from various fields.

For University Management:

- i. Accurate Attendance Monitoring: Provides real-time data for identifying students with poor attendance and timely interventions.
- ii. Resource Allocation: Enables better allocation of faculty, teaching assistants, and facilities based on actual attendance data.
- iii. Efficient Data Management: Reduces paperwork and errors, leading to more efficient data management.

For Professional Organizations:

- i. Efficient Training Tracking: Efficiently tracks attendance for training programs and workshops.
- ii. Accurate Records for Compliance: Provides verifiable training attendance records for regulatory purposes.
- iii. Automated Certification: Streamlines the process of generating completion certificates based on attendance.
- iv. Efficient Resource Allocation: Helps plan for trainers, materials, and resources based on expected attendance.
- v. Professional Development Tracking: Individuals can track their own professional development progress.
- vi. Quality Assurance: Ensures training sessions are conducted as planned and participants are present.
- vii. Enhanced Security: Adds a layer of security to events, ensuring only authorized participants' access resources.
- viii. Event Management: Facilitates efficient management of conferences and seminars.
- ix. Evidence for Funding/Grants: Serves as evidence of program impact and reach for funding purposes.

For Government:

- i. Resource Allocation: Enables better allocation of resources to educational institutions based on actual student attendance data, ensuring effective utilisation.
- ii. Improved Educational System: Leads to improved attendance tracking, resource optimization, enhanced accountability, and a more conducive learning environment.

Conclusion

The proposed BSMSLA system, leveraging biometric technology and adhering to relevant theoretical frameworks like TAM and UTAUT, is designed to significantly enhance attendance management in Nigerian higher institutions. By addressing the documented issues of traditional methods, it aims to improve data accuracy, streamline administrative tasks, promote student accountability, and ultimately contribute to better academic performance. The mixed-method approach will provide both quantitative evidence of its effectiveness and qualitative insights into user perceptions, paving the way for a more efficient and effective educational environment.

Recommendations

- i. The use of automated attendance system in tertiary institutions offers tremendous benefits to lecturers and students as it also ease the demanding tasks of managing and maintaining of students information by lecturers and administrators of Nigerian tertiary institutions. Hence, need for further researches on the development of automated attendance system at different levels of education, allocation of more funds to conduct researches on automated attendance system in Nigeria by Government organizations, agencies and Non-Governmental Organizations,

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Qualitative Study on Integration of Biometric-Based System for ... Ogunje, B. F., Et. al.
(2025)

- ii. procurement of technologies that can enhance the use of automated attendance system in schools.
- iii. More conferences, seminars and workshops should be organized for Nigerian educational stakeholders to keep them abreast with the global emerging technologies on automated attendance system.
- iv. Research institutes in Nigeria should consider designing and development of more automated attendance system for lecturers and students.

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