The Journal of Informatics, Vol. 4, Issue 1 (pages 187-202)

eISSN: 2953-254X, ISSN: 2714-1993 (Print)
Received: July, 2024 Published: October, 2024
DOI: https://doi.org/10.59645/tji.v4i1.231

****Original Research****

STRENGTHENING OF STUDENTS' CLASS ATTENDANCE USING BIOMETRIC AUTHENTICATION SYSTEM TO ENHANCE DELIVERY OF COMPETENCE-BASED QUALITY EDUCATION

Authors

Anold S. Nkata

Department of Information and Communication Technology.

Arusha Technical College

ORCiD: https://orcid.org/0000-0002-6826-3152

Abstract

Delivery of competence-based quality education for students' academic achievements strongly correlates with effective student class attendance. In Tanzania, no student registered by the NACTVET is eligible for examination unless he/she has earned 75% of class attendance. In this regard, most education institutions use paper-based class attendance to manage students' class attendance. The system requires students to sign to his/her name as the class session is in progress. Despite this effort made by educational institutions still, the manual process of monitoring and tracking students' class attendance remains challenging for module facilitators. This study examined the problem associated with the paper-based methods of monitoring and tracking students' class attendance by collecting primary data using questionnaires from students of higher learning institutions in the Arusha Region. After the data analysis findings revealed that paper-based students' class attendance has many drawbacks which include time-consuming and students' signature impersonation. The paper-based class attendance facilitates dishonest students to forge the signatures of the absent students. To address these challenges, the study recommends education institutions implement cost-effective biometric class attendance such as fingerprints or facial recognition scanners, which can automatically monitor and keep students' attendance records on the database without interfering with the class session.

Keywords: Biometric Class Attendance, Higher Learning Institutions, Students' Class Attendance.

1.0 INTRODUCTION

Biometric Technology is a technological measure used for identifying and authenticating individuals through the use of fingerprint mapping, facial recognition, or retina scans (Hemalatha, 2020; Ula et al., 2021). Biometrics technology has emerged as a security transformation technology in the 21st century (Sutrop, 2010). The technology efficiently improved decision-making processes, in diverse applications by improving the accuracy and real-time identification and authentication of individuals for security control purposes.

Worldwide, most educational institutions are currently using biometric technology for managing educational activities such as monitoring and controlling the students' class attendance during examinations and class sessions (Bhattarai et al., 2020). However, some educational institutions in the developing country still use the paper-based system for students' class attendance during examinations and for class periods (Bhattarai et al., 2020). Those educational institutions that use biometric technology, the system has significantly improved the accuracy and reliability process of tracking and monitoring students' class attendance in real-time compared to the use of the manual system (Hernandez-de-Menendez et al., 2021; Hoo & Ibrahim, 2019). Mover technology has improved students' class attendance in technical vocational training education and higher-learning institutions have positively contributed to

delivering quality education, leading to competence-based student achievement (Ancheta et al., 2021).

In contrast, the educational institutions that use paper-based class attendance systems have contributed to the delivery of incompetence-based students' academic achievement. The poor process of tracking, monitoring, and managing students' class attendance has significantly contributed to poor academic performance (Ula et al., 2021). Students' academic performance has a strong association with effective class attendance (Guryan et al., 2021)

Effective processes of monitoring and maintaining records of the student's class attendance remain a challenge in most of the higher-learning educational institutions (C.O et al., 2013). The paper-based class attendance system which requires module facilitators. to provide the printed paper containing the names of the students for signing leads to the lack of students' concentration on the ongoing lecture session. Some modules called cross-cutting modules whereby students of different courses are combined to form one large class make it difficult for the lecturer and tutors to effectively monitor the students' class attendance. Moreover, the paper-based system of tracking and monitoring students' class attendance leads to errors during report preparation for academic use. and tutors to manually compute the absent students, which is time-consuming (Dassanayake & Wanniarachchi, 2021; Olanipekun & Boyinbode, 2015). Furthermore, manual work whereby the present students are required to sign to their names provides room for dishonest students to forge and impersonate the passwords of other absent students.

2.0 OBJECTIVE OF THE STUDY

The objective of this research study is to investigate the effective methods of tracking, monitoring, and managing students' class attendance at technical vocational training educational and higher-learning institutions. Cost-effective, real-time, and accurate methods of tracking, monitoring, recording, and keeping the students' class attendance for future academic use remain significant benefits of enhancing the work productivity of module facilitators.

3.0 LITERATURE REVIEW

This section critically reviewed the related works of past scholars. The part consists of a theoretical and empirical literature review.

3.1 Theoretical Literature Review

We live in cyberspace where digital transformation has effectively enhanced the accuracy and timely dissemination of information compared to manual systems (Rathod et al., 2017). The application of biometric technology for the automatic process of recording and keeping student class attendance cannot be ignored by technical vocational training education and higher learning institutions to enhance the work productivity of module facilitators in monitoring and tracking the attendance of students during class sessions (Al Hajri et al., 2019). According to the Tanzanian Government Notice No. 74 Published on 12/03/2004, of the National Council For Technical Education (Examinations) Regulations, 2004, currently NACTVET, no student is allowed to sit for an examination unless he/she has attended at least 75 % of the class sessions per semester (NACTVET, 2004). This regulation aims to force students to effectively attend class sessions physically to acquire the competence-based knowledge and skills that demonstrate practical education for self-employment (Ramadhani, 2017).

One of the core duties of the module facilitator of the technical vocation training education and higher learning institution is to teach students by enhancing competence-based quality education by making sure students effectively attend the class session (Mohzana et al., 2024). The competency-based quality education requires facilitators to involve students in learning processes (Pinter et al., 2020). This learning practice requires students to effectively attend the class session and module facilitators to take their attendance records for future academic use. In a class containing a large number of students, it is challenging for the module facilitators to effectively take the attendance of students using paper paper-based system. The application of a biometric authentication system remains a scientific solution for a class containing a larger number of students to automatically record students' class attendance and store them on the computer-based database system for future academic use. Biometric technology eliminates the drawbacks of paper-based students' class attendance such as signature impersonation by enhancing accuracy, and real-time processes of monitoring and tracking students' class attendance (Alluwaimi, 2020). Computer vision, fingerprints, Iris biometric recognition, facial recognition, and Radio Frequency Identification (RFID) biometric technology is a smart technology for automatically tracking and monitoring students' class attendance (Hernandez-de-Menendez et al., 2021; Rahman, 2016).

There is a high correlation between students' academic performance and students class attendance in a competence-based quality education system (Mkonongwa & Department, 2016). Competency-based quality education well known as CBET as opposed to the KBET education system emphasizes practical skills that require students to perform practical applications (Mbwillo, 2008). A study conducted by (Guryan et al., 2021; Kassarnig et al., 2017) reveals that students' class attendance has a positive impact on the student's academic achievement.

3.2 Empirical Literature Review

A study conducted by (Feng et al., 2020; Humaun Kabir et al., 2021) highlights the use of facial recognition detection systems in tracking students' class attendance. This study contributed knowledge to improving the process of tracking and monitoring the student's class attendance. However, this technology only best suits the class containing a small number of students to have the quality of the image. For a class containing a large number of students, the quality of images will be low.

Another study conducted by (Haq & Saqlain, 2023), also pinpoints the knowledge gap of implementing RFID students' class attendance using a machine learning technology. The study offered a practical insight into how RFID can be utilized effectively to deliver robust, secure, and automatic student class attendance. The RFID technology does not offer a cost-effective solution as it requires RFID hardware such as Readers, antennas, cables, RFID tags, and licensed setup Software to operate.

A study conducted by (Bhavana et al., 2020) focused on the use of Computer vision and a Local Binary Pattern Histogram (LBPH) algorithm. The study contributes scientific knowledge on automatic class attendance, but it did not consider the cost-effectiveness of institutions running under financial constraints.

4.0 METHODOLOGY

Research methodology is a scientific approach used to describe the methods and techniques used to investigate the research study on a specific topic to contribute scientific knowledge (R., 2004). The approach outlines the research design, data collection methods, sampling techniques, sample size, materials, and tools used for data analysis and interpretations. This study, adopted various methods and techniques to ensure validity and reliability of the

research findings. The figure below describes various phases used to design this research study.

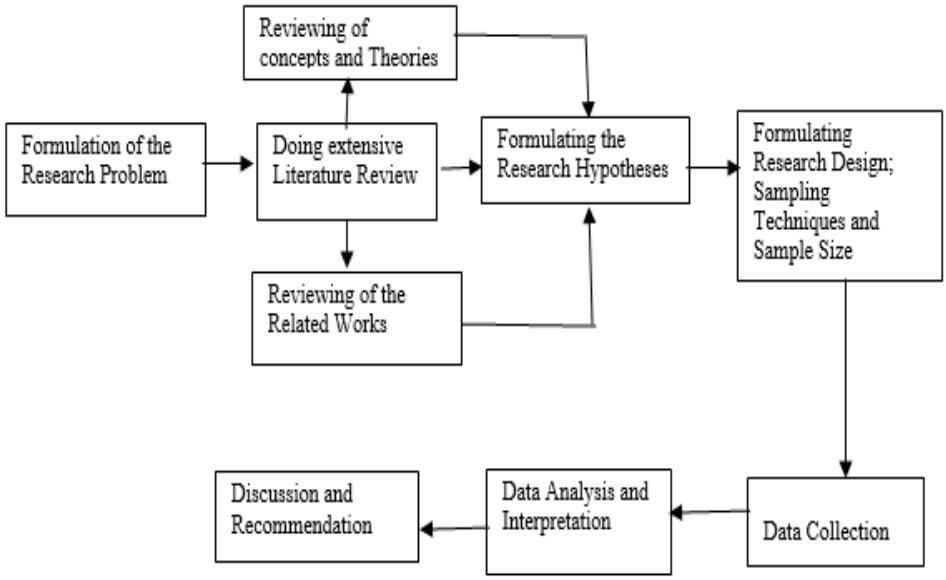

Figure 1: Research Design Phases

4.1 Sampling

This research study was conducted in the Arusha region of northern Tanzania. Arusha region consists of government-owned institutions and privately-owned institutions. Most of the government educational institutions that offer basic technician, ordinary diploma, and bachelor degree programs run their courses under the supervision of the National Council for Technical and Vocational Education and Training (NACTVET). The NACTVET enforces the competence-based delivery of quality education through students' eligibility examination entry qualification class attendance policy. Only students who meet a class attendance of at least 75% are allowed to sit for the semester examination.

4.2 Sampling Techniques

Due to the significant benefits of the student's class attendance supervised by the NACTVET aimed at enhancing the delivery of quality education through competence-based education training (CBET), this study used purposeful sampling techniques to select the two government institutions for the study. Since the study requires the application of Science, Technology, and Innovation (STI) to effectively address the challenges of the current students' class attendance system, the study selected third-year students pursuing ICT-related programs for the data collection to contribute knowledge on the use of digital technology to enhance the effective

processes of tracking, monitoring and managing the students' class attendance.

Moreover, the study collected the primary data which aimed at contributing scientific knowledge to Tanzanian education institutions in delivering quality education for self-employment by forcing students to attend class periods to acquire important class-taught knowledge and skills rather than studying by cramming online.

4.3 Sample Size

For the accuracy of the research study, the researcher used a simple random sampling technique to design a sample size from a finite population of third-year students pursuing Information Technology Computer Science, and cyber security programs. To ensure the validity and reliability of primary data collected from third-year students, the study used a Cochran formula for the computation of the sample size of ninety-six. See the Cochran formula for the equation below:

$$n_o = \frac{z^2 p(1-p)}{me^2}$$

$$n_o = \frac{1.96^2\ (1-0.5)\ 0.5}{0.01^2} = 96$$

Wherein n_0 stands for the sample size**, Z** for the z-score**, P** for the population proportion, and ***me*** for the margin error. This study used a **Z-score** of 1.96 for a confidence level of 95%, a margin error (***me***) of 1%, and a population proportion **P** of 50% to obtain a sample size of ninety-six representatives of the study.

4.4 Data Collection Methods

To address the objective of the study, the researcher used questionnaires to collect quantitative data. Quantitative data is the type of data that is in the form of numerical numbers used to represent items in a research study which can be counted and recorded in a numerical number system (Observations et al., 2020). The questionnaires consisted of open-ended questions and closed-ended questions were distributed to the respondents through the use of the Google Form platform.

4.5 Ethical Consideration and Demographic Factors

The researcher considered all ethical issues and demographic information in this study. Data protection and privacy of the respondents were taken under high consideration for the

significant benefits of the study and for the sustainable development of Tanzanian educational institutions in delivering quality education for the students' academic achievements of competence-based quality education. In this respect, the study considers the level of study of the respondents and their field of study as the third-year cyber security Information Technology and Computer Science students are both proficient in database security.

4.6 Data Analysis

Data analysis is the systematic process of using statistical software programs to manipulate and organize the raw data collected from the respondents into full meaning which can be used to conclude (Kothari, 2014). Before data analysis, the data cleaning process was conducted to identify and fix errors to ensure the quality of data from the respondents. The term data cleaning refers to the systematic process of identifying and removing incomplete data within a dataset collected from the respondents (Koshti, 2012). After the data cleaning process, the collected data was analyzed and the results were presented using tables and charts.

4.7 Quality Procedures and Control

To ensure the validity and reliability of the study, the researcher selected the government education institutions who required by the NACTVET to enforce students' class attendance for the students' competence-based education achievements. Moreover, to get the quality of data collected from the students, the study collected data from third-year students pursuing a bachelor's degree in computer science and information technology and cyber security who have three years experiences of attending lecture sessions.

5.0 RESULTS

This part of the research article presents the interpretation of the results. The results of the data analysis were presented in graphs and tables to respond to the general objective of the research study as follows:

5.1 Identifying types of the current system used by educational institutions in monitoring and managing the students' class attendance.

To identify the type of student class attendance used in Tanzanian educational Institutions to monitor, control, and manage the attendance of students during lectures and tutorial sessions. The researcher collected primary data from ninety-six third-year students pursuing bachelor's degrees in Information Technology, Computer Science, and Cyber Security from educational

institutions. In this respect, respondents were asked about what types of systems their educational institution uses to monitor, control, and manage the students' class attendance during lecture and tutorial sessions. After the data analysis, findings revealed that 100 % of the current system used by educational institutions for monitoring, controlling, and managing the student's class attendance is in the paper-based system. The paper-based system requires the module facilitators to come with printed paper containing the names of students whereby only students who attended the class are required to sign their names. The system made students lose concentration by taking his/her time cross-checking his/her name. The table below illustrates the findings.

Table 1: Types of the Current System used currently

Description of the Answer from the Respondents	Number of Respondents	Percentage of Respondents
Paper-based system (Manual System)	96	100%
Biometric system	0	0%
I Know nothing	0	0%
Total number of respondents	96	100%

5.2 Review of the effectiveness of the current system used by educational institutions in tracking, monitoring, and managing the student's class attendance.

To determine whether the current system used by educational institutions to monitor and manage the students' class attendance effectively enhances the processes of tracking and monitoring the attendance. In this respect, the study collected primary data from ninety-six students pursuing bachelor's degrees in Information Technology, Computer Science, and Cyber Security from educational institutions. After the data analysis findings revealed that, eighty-three of the respondents out of ninety-six which is equivalent to 86.46%, said the current system used to track, monitor, and manage students' class attendance which is paper paper-based system is ineffective. This is because the paper-based students' class attendance currently used by most educational institutions provides room for some students to impersonate the signatures of their friends who do not attend the class session. Nine of the respondents out of ninety-six said the system is effective while four of the respondents out of ninety-six said they don't know whether the current system which is paper paper-based

system is effective or ineffective. The figure below illustrates the findings about the status of the paper-based class attendance system which is currently used by most academic institutions to monitor students' class attendance.

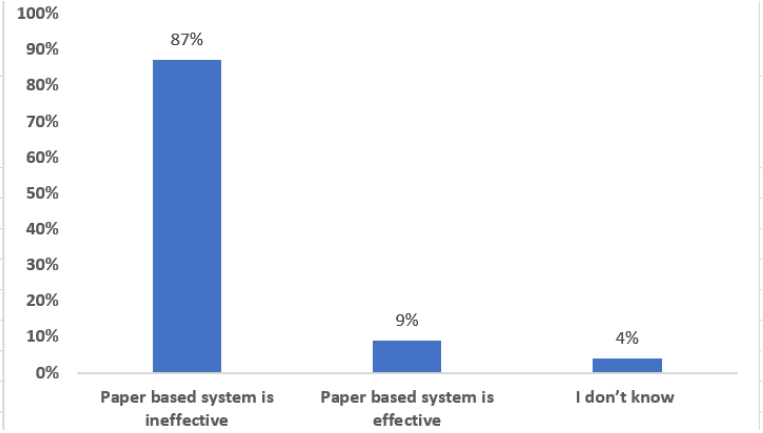

Figure 2: Status of the Paper-Based Class Attendance System

5.3 Investigation of the relationship between students' class attendance and students' academic achievements.

The study investigated furthermore on whether there is relation between students' class attendance and students' academic achievements. In this respect, the study collected data from a ninety-six-sample size of third-year students. After the data analysis findings revealed that, all ninety-six respondents which is equivalent to 100% of the respondents said that, the students' class attendance has a positive impact on students' academic achievements. The table below illustrates the findings of the respondents.

Table 2: Relationship between Students' Class Attendance and Academic Achievement

Description of the Answer from the Respondents	**Number of Respondents**	**Percentage of Respondents**
Students' class attendance has a positive impact on academic performance	96	100%
Students class attendance doesn't have any positive impact on academic performance	0	0%
I Know nothing	0	0%
Total number of respondents	96	100%

Based on the above feedback, the study used linear regression to examine the relationship

between students' class attendance and performance. A sample size of ninety-six students was used to evaluate the correlation between students' academic performances in two continuous assessment tests of the module of Database Security. After the regression analysis, the study revealed that students with high percentages of class attendance performed better in two continuous assessment tests than those with a smaller percentage of class attendance in a particular module. This is because students who don't attend the class sessions fail to achieve competencies knowledge and practical skills which require them to demonstrate practical skills in performing practical activities. This shows that the more student attends the class sessions the student gets involved in performing related tasks of the sub-learning outcomes of the particular module by getting guidance from his/her lecturer instead of having private study. The figure below illustrates the relationship between students' class attendance and academic achievement.

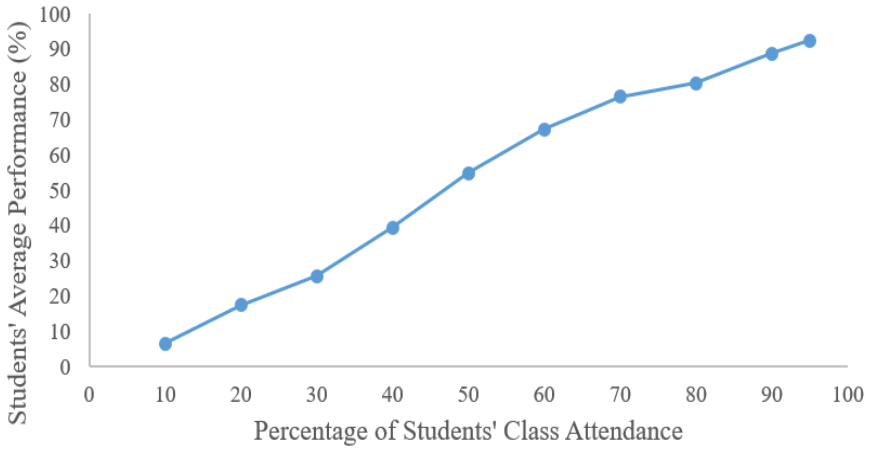

Figure 3: Relationship Between Student's Class Attendance and Academic Achievements

5.4 Reasons why most students tend not to attend the lectures and tutorial sessions

To investigate why most of the students, do not attend the class lectures and tutorials especially when they get to the next higher level of the year of study as compared to when they were in the first year, the study collected data from ninety-six sample size of third year students. After the data analysis findings revealed that, forty-four of the respondents out of the ninety-six total respondents which is equivalent to 45% said most students do not attend class sessions for no academic reasons or factors, ten of the respondents which is equivalent to 11 % of the total respondents said most of the students do not attend the class due to the limited time as some are employed. Twenty-five of the respondents which is equivalent to 26% said some of the students believe in their private study as materials are freely available on the internet where they study in their private time. Only seventeen of the respondents

which is equivalent to 18% said most of the enrolled students in technical vocational training education and higher learning educational institutions did not attend the class session due to their foolish and mature age. Figure 2 illustrates the findings from the respondents.

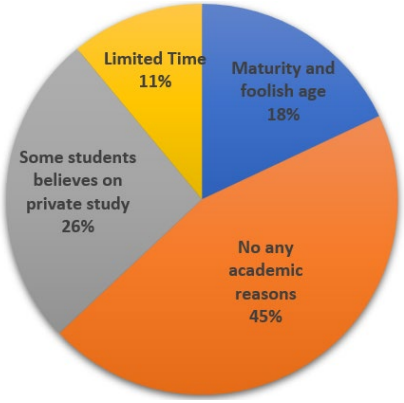

Figure 4: Factors Affecting Student's Class Attendance

5.5 Discussion of the Results

Based on the above findings, this study noticed that, in this era of cyberspace where learning materials are popularly available over the internet, most students of technical vocational training education and higher learning institutions do not attend class sessions effectively. Despite the availability of learning materials over the Internet, those students who don't attend the class sessions effectively tend to miss important continuous assessments such as presentations, quizzes, and other class activities that used to be assessed by module facilitators during practical sessions. Ineffective class attendance leads students to poor academic achievements as most of them end up getting supplementary, absconded, and discontinuous of their study due to poor score of the Grade Point Average (GPA).

The current system which is a paper-based system used by most educational institutions in tracking, monitoring, and managing the attendance of students during class sessions is ineffective. The paper-based system comprises various shortcomings such as signature impersonation, time-consuming for module facilitators. to take records of students who attended the session, stationary costs associated with printing names of students, consumption of high storage space for keeping paper-based attendance, and error-prone encounters by module facilitators during computation of the percentages of the attendance of individual students per semester. Not only that, but also the paper-based student class attendance requires the lecturer to take attendance, keep records manually, and compute the percentage

of the attendee students added to the administrative activities of the lecturer.

6.0 CONCLUSION AND RECOMMENDATION

Due to the significant benefits of the student's class attendance, this study recommends the use of computerized students' class attendance rather than a paper-based system in tracking, monitoring, and managing the student's class attendance. To accurately and effectively enhance the practices of tracking, monitoring, and managing the student's class attendance, the study recommends the implementation of biometric technologies such as computer vision, or fingerprints which can automatically record the students' class attendance during class sessions. Computer vision or fingerprints will reduce the administrative work of the lecturer and enhance the efficient process of tracking, monitoring, and managing the process of accurately keeping records of students' class attendance.

Apart from the use of computer vision, and fingerprint class attendance technology, the educational institutions are recommended to conduct technical and economic feasibility studies to determine the cost-benefit analysis of implementing other popular available biometric class attendance systems such as Iris biometric recognition, facial recognition detection system, and Radio Frequency Identification (RFID).

However, due to various factors such as financial constraints, the number of students per class session, and technological factors, the use of Iris biometric recognition, facial recognition detection system, and Radio Frequency Identification (RFID) using machine learning can bring future challenges to academic institutions. For example, the RFID class attendance technology does not offer a cost-effective solution as it requires RFID hardware such as Readers, antennas, cables, RFID tags, and licensed setup Software to operate. The facial recognition detection system requires a small number of students per class session to improve the quality of the image. The large number of students per class session may lead to the small size of the image and poor quality of the image processed by the system.

Furthermore, the study is concluded by advising the educational scholars of the education institutions to implement the biometric system to be used during the examination as an access control mechanism for identifying and authorizing students who are eligible to enter the examination room. The system will solve the current challenges encountered during examination whereby the students have a chance of counterfeiting the examination number

or can enter the examination room and do the examination on behalf of his/her friends.

REFERENCES

Al Hajri, E., Hafeez, F., & Ameer Azhar, N. V. (2019). Fully automated classroom attendance system. *International Journal of Interactive Mobile Technologies*, *13*(8), 95–106. https://doi.org/10.3991/ijim.v13i08.10100

Alluwaimi, A. (2020). *Department of Electrical Engineering Senior Design Project Report Face Detection and Recognition Student Attendance System In partial fulfillment of the requirements for the award of the bachelor's degree program*.

Ancheta, R. F., Daniel, D., & Ahmad, R. (2021). Effect of Class Attendance on Academic Performance. *European Journal of Education Studies*, *8*(9), 115–131. https://doi.org/10.46827/ejes.v8i9.3887

Bhattarai, N., Bernasek, A., & Pena, A. A. (2020). Factors Affecting School Attendance and Implications for Student Achievement by Gender in Nepal. *Review of Political Economy*, *32*(2), 259–282. https://doi.org/10.1080/09538259.2020.1769296

Bhavana, D., Kumar, K. K., Kaushik, N., Lokesh, G., Harish, P., Mounisha, E., & Tej, D. R. (2020). Computer vision-based classroom attendance management system with speech output using LBPH algorithm. *International Journal of Speech Technology*, *23*(4), 779–787. https://doi.org/10.1007/s10772-020-09739-2

Dassanayake, D., & Wanniarachchi, W. (2021). Challenges of manual attendance system towards student motivation. *International Research Conference (IRC) of the Kotelawala Defence University (KDU)*, 516–525.

Dea Elias, J., & Lubua, E. W. (2021). The Impact of Usability, Functionality and Reliability on Users' Satisfaction During Library System Adoption. *The Journal of Informatics*, *1*(1). https://doi.org/10.59645/tji.v1i1.13

Feng, D., Wang, P., & Zu, L. (2020). Design of Attendance Checking Management System for College Classroom Students Based on Fingerprint Recognition. *Proceedings of the 32nd Chinese Control and Decision Conference, CCDC 2020*, 555–559. https://doi.org/10.1109/CCDC49329.2020.9164638

Guryan, J., Christenson, S., Cureton, A., Lai, I., Ludwig, J., Schwarz, C., Shirey, E., & Turner, M. C. (2021). The Effect of Mentoring on School Attendance and Academic Outcomes: A Randomized Evaluation of the Check & Connect Program. *Journal of Policy Analysis and Management*, *40*(3), 841–882. https://doi.org/10.1002/pam.22264

Haq, H. B. U., & Saqlain, M. (2023). Iris Detection for Attendance Monitoring in

Educational Institutes Amidst a Pandemic: A Machine Learning Approach. *Journal of Industrial Intelligence*, *1*(3), 136–147. https://doi.org/10.56578/jii010301

Hemalatha, S. (2020). A systematic review on Fingerprint-based Biometric Authentication System. *International Conference on Emerging Trends in Information Technology and Engineering, Ic-ETITE 2020*, 1–4. https://doi.org/10.1109/ic-ETITE47903.2020.342

Hernandez-de-Menendez, M., Morales-Menendez, R., Escobar, C. A., & Arinez, J. (2021). Biometric applications in education. *International Journal on Interactive Design and Manufacturing*, *15*(2–3), 365–380. https://doi.org/10.1007/s12008-021-00760-6

Hoo, S. C., & Ibrahim, H. (2019). Biometric-based attendance tracking system for education sectors: A literature survey on hardware requirements. *Journal of Sensors*, *2019*. https://doi.org/10.1155/2019/7410478

Humaun Kabir, M., Roy, S., Tofail Ahmed, M., & Alam, M. (2021). Smart Attendance and Leave Management System Using Fingerprint Recognition for Students and Employees in Academic Institute. *Article in International Journal of Scientific Research*, *6*(September), 350. www.ijstr.org

Kassarnig, V., Bjerre-Nielsen, A., Mones, E., Lehmann, S., & Lassen, D. D. (2017). Class attendance, peer similarity, and academic performance in a large field study. *PLoS ONE*, *12*(11), 1–15. https://doi.org/10.1371/journal.pone.0187078

Koshti, S. D. (2012). *Research methodology*.

Kothari, R. (2014). *Research Methodology: Methods and Techniques* (Third Edit). New Age International (P) Limited, Publishers: New Delhi.

Mbwillo, J. S. (2008). *Competency-Based Education and Training (CBET) on Students ' Engagement in Learning Process at Tanzania Public Service College-Mbeya Campus*.

Mkonongwa, L. M., & Department. (2016). Competency-based teaching and learning approach towards quality education. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, *6*(August), 128.

Mohzana, Arifin, M., Pranawukir, I., Mahardhani, A. J., & Hariyadi, A. (2024). Quality Assurance System In Improving The Quality Of Education In Schools. *Mudir (Jurnal Manajemen Pendidikan)*, *6*(1), 115–123. https://ejournal.insud.ac.id/index.php/MPI/article/view/830/646

NACTVET. (2004). *GOVERNMENT NOTICE NO. 74 PUBLISHED ON 12/03/2004* (Issue 74, pp. 1–37).

Observations, S., More, R., One, T., Critically, T., Everyday, A., & Agreement, I. (2020). *Chapter 6 Methods of Data Collection Introduction to Methods of Data Collection The*

Nature of Observations Ways of Observing Participant vs. Nonparticipant Observation Scheduling Observations Defining the Behavior to Be Observed Specific Techniques for Re (pp. 1–26). https://uca.edu/psychology/files/2013/08/Ch6-Methods-of-Data-Collection.pdf

Olanipekun, A. A., & Boyinbode, O. K. (2015). An RFID-based automatic attendance system in educational institutions of Nigeria. *International Journal of Smart Home*, *9*(12), 65–74. https://doi.org/10.14257/ijsh.2015.9.12.07

Pinter, R., Čisar, S. M., Balogh, Z., & Manojlovi, H. (2020). *Enhancing Higher Education Student Class Attendance through Gamification*. *17*(2), 13–33.

R., K. C. (2004). *Research Methodology, methods, and Techniques* (2nd Revise). New Age International (P) Limited, Publisher 4835/24, Ansari Road, Daryaganj, New Delhi - 110002.

Rahman, M. M. (2016). Barriers to M-commerce Adoption in Developing Countries – A Qualitative Study among the Stakeholders of Bangladesh. *The International Technology Management Review*, *3*(2), 80–91.

Ramadhani, M. (2017). Curriculation and Competence Based Education Training (CBET) in Tanzania: A Critical Assessment of Public Administration and Management (PAM) Curricula at Tanzania Public Service College (TPSC). *HOLISTICA – Journal of Business and Public Administration*, *8*(2), 17–40. https://doi.org/10.1515/hjbpa-2017-0010

Rathod, H., Ware, Y., Sane, S., Raulo, S., Pakhare, V., & Rizvi, I. A. (2017). Automated attendance system using machine learning approach. *2017 International Conference on Nascent Technologies in Engineering, ICNTE 2017 - Proceedings*, *5*(09), 24–26. https://doi.org/10.1109/ICNTE.2017.7947889

Sutrop, M. (2010). Ethical issues in governing biometric technologies. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *6005 LNCS*, 102–114. https://doi.org/10.1007/978-3-642-12595-9_14

Ula, M., Pratama, A., Asbar, Y., Fuadi, W., Fajri, R., & Hardi, R. (2021). A New Model of the Student Attendance Monitoring System Using RFID Technology. *Journal of Physics: Conference Series*, *1807*(1). https://doi.org/10.1088/1742-6596/1807/1/012026