

Classscan: A Smart Classroom Identification Scanner for Attendance and Access Monitoring

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ABSTRACT

Attendance monitoring is an important aspect of classroom management because it helps teachers maintain accurate student records and monitor participation. However, traditional attendance methods, such as manual roll calls and paper-based records, are often time-consuming and prone to human error. This study developed ClassScan, a smart classroom identification scanner designed to automate attendance monitoring using Radio Frequency Identification (RFID) technology. The system was developed using an ESP32 microcontroller, RFID scanner, OLED display, DS3231 Real-Time Clock module, Micro SD Card module, and ESP32-CAM. A developmental research design was employed to develop and evaluate the system. Six teacher-participants assessed the usability, effectiveness, and operational performance of the prototype through a structured evaluation questionnaire. The findings revealed that the system obtained an overall mean score of 4.48, interpreted as "Strongly Agree," indicating a high level of user acceptance. Participants reported positive perceptions regarding the system's ease of use, attendance-recording capability, and operational performance during testing. The findings suggest that ClassScan demonstrates potential as a practical attendance-monitoring solution within a localized educational setting. Further studies involving larger samples and more comprehensive validation procedures are recommended.

Keywords: RFID-Based Attendance System, Attendance Monitoring, Smart Classroom Technology, Educational Technology, ESP32, Classroom Management

INTRODUCTION

Attendance monitoring plays a vital role in ensuring effective classroom management and maintaining accurate student records. In many schools, attendance is still recorded manually through roll calls and attendance sheets. Although these methods are widely used, they often consume valuable instructional time and may result in recording errors, misplaced records, and inefficiencies in data management (Muslim et al., 2024; Calo et al., 2021). With the continuous advancement of technology, educational institutions have begun adopting digital solutions to improve classroom operations. Automated attendance systems have become increasingly popular because they provide faster and more reliable attendance recording compared to traditional methods. RFID technology has gained attention due to its ability to identify users quickly and accurately through contactless scanning (El Mrabet & Ait Moussa, 2020). Studies have shown that RFID-based attendance systems can reduce administrative workload, improve accuracy, and enhance classroom efficiency (Farg, 2023; Ishaq & Bibi, 2023).

The integration of smart technologies in education is consistent with the Technology Acceptance Model, which suggests that users are more likely to adopt systems that are useful and easy to use (Davis, 1989). Likewise, Rogers' Diffusion of Innovations Theory explains that technological innovations offering clear advantages over existing practices are more likely to be accepted and implemented (Rogers, 2003). In response to the limitations of traditional attendance methods, this study developed ClassScan, a smart classroom identification scanner that utilizes RFID technology to automate attendance monitoring. The study aimed to evaluate the system's effectiveness, usability, and accuracy in a classroom setting.

Research Objectives

The primary objective of this study was to develop and evaluate ClassScan, a smart classroom identification scanner for automated attendance monitoring. Specifically, the study aimed to:

1. Design and develop a functional RFID-based attendance monitoring system capable of accurately identifying users and recording attendance data.
2. Evaluate the usability, effectiveness, and reliability of the ClassScan system based on the assessments of teacher-participants.
3. Assess the operational performance of the system in terms of attendance-recording accuracy, duplicate-entry prevention, and data-logging reliability.
4. Determine the potential applicability of the system as a classroom attendance-monitoring solution within a localized educational setting.

Significance of the Study

The findings of this study may provide valuable contributions to various stakeholders within the educational sector.

Students. The ClassScan system offers a more efficient and accurate method of attendance recording, reducing the likelihood of attendance-related errors and improving record management.

Teachers. The system may reduce the administrative burden associated with manual attendance checking, thereby allowing teachers to allocate more time to instructional activities and classroom management.

School Administrators. The automated recording and storage of attendance data can facilitate more efficient monitoring, reporting, and management of student attendance records.

Educational Institutions. The study demonstrates the potential application of low-cost RFID-based technologies in improving administrative processes and supporting digital transformation initiatives within schools.

Future Researchers. The study may serve as a reference for future investigations involving RFID-based attendance systems, embedded systems development, and educational technology applications.

Scope and Delimitation

This study focused on the design, development, and evaluation of the ClassScan system for attendance monitoring. The prototype utilized RFID technology for student identification and attendance recording. The study was conducted within a limited classroom setting and involved six teacher-participants who evaluated the effectiveness, usability, and accuracy of the system. The study did not include large-scale implementation across multiple schools and did not incorporate biometric identification technologies. In addition, the evaluation was limited to a small number of participants; therefore, the findings may not fully represent broader educational settings. Future studies involving larger sample sizes and multiple institutions are recommended.

METHODOLOGY

Research Design

This study employed a developmental research design. Developmental research focuses on the design, creation, testing, and evaluation of products intended to solve specific problems or improve existing processes. This approach was considered appropriate because the primary objective of the study was to develop a functional attendance monitoring system and evaluate its performance in a classroom environment. The ClassScan prototype was developed using an ESP32 microcontroller as the primary processing unit. RFID technology was

used for student identification and attendance recording. Attendance data were stored through a Micro SD Card module, while a DS3231 Real-Time Clock module provided accurate date and time records. An OLED display provided real-time user feedback, and an ESP32-CAM module was integrated for image-based verification. Additional components included RGB LED indicators, push buttons, a buzzer, rechargeable batteries, and a DC-DC buck converter.

Participants of the Study

The participants of the study consisted of six teacher-participants from Mindanao State University–Maigo College of Education, Science and Technology. These participants were selected to evaluate the effectiveness, usability, reliability, and accuracy of the ClassScan system. Their evaluations provided valuable feedback regarding the performance and practicality of the prototype in a classroom setting.

Research Instruments

Data were collected using a structured evaluation questionnaire adapted from established evaluation frameworks, including the System Usability Scale (SUS), the Technology Acceptance Model (TAM), and ISO software quality standards. Data were collected using a structured evaluation questionnaire adapted from established evaluation frameworks, including the System Usability Scale (SUS), the Technology Acceptance Model (TAM), and relevant ISO software quality standards. The questionnaire measured participants' perceptions of the system's usability, effectiveness, operational performance, user satisfaction, and perceived reliability. A separate operational evaluation checklist was utilized to assess whether the system accurately recorded attendance, correctly identified users, prevented duplicate entries, and maintained consistent attendance records during testing.

Data Gathering Procedures

The development of the ClassScan system began with the assembly and integration of the necessary hardware components, including the ESP32 microcontroller, RFID module, RTC module, OLED display, ESP32-CAM, buzzer, RGB LED indicators, and power supply components. After assembly, the system was programmed and tested to ensure proper functionality. Once the prototype was completed, classroom simulations and testing activities were conducted. Teacher-participants observed and evaluated the system while attendance data were recorded through RFID scanning. Following the testing phase, the participants completed the evaluation questionnaire and accuracy checklist. The collected data were organized, tabulated, and analyzed using descriptive statistics, particularly frequency counts and mean scores. The results were then interpreted to determine the effectiveness, usability, and accuracy of the ClassScan system.

Data Analysis

To figure out what the survey scores meant, we looked at the frequency of answers and calculated the standard mean scores. We interpreted their 1-to-5 Likert scale responses using the simple reference grid below:

Rating	Range	Verbal Description	Qualitative Description	Interpretation
5	4.21-5.00	Strongly Agree (SA)	Very High	The teacher-respondents view the ClassScan system as effective, reliable, and ready for classroom use.
4	3.41-4.20	Agree (A)	High	Teachers find the ClassScan system effective and

				practical, with minor concerns.
3	2.61-3.40	Neutral (N)	Moderate	Teachers show moderate agreement, indicating acceptable functionality but needing improvements.
2	1.81-2.60	Disagree (D)	Low	Teachers perceive low effectiveness and usability
1	1.00-1.80	Strongly Disagree (SD)	Very Low	Teachers find the ClassScan system ineffective and unsuitable, requiring major improvements.

The collected data were analyzed using descriptive statistical techniques, including frequency counts and weighted mean scores. Responses to the evaluation questionnaire were measured using a five-point Likert scale, where higher scores indicated more favorable evaluations of the ClassScan system. The computed mean scores were interpreted using predefined descriptive and qualitative categories to determine the perceived effectiveness, usability, and reliability of the system.

RESULTS

The ClassScan system was evaluated by six teacher-participants using a structured evaluation questionnaire. The assessment focused on the system's usability, effectiveness, reliability, and overall functionality.

The evaluation results revealed an overall mean score of 4.48, corresponding to the verbal interpretation of "Strongly Agree." This result indicates that the respondents perceived the system as highly effective and suitable for classroom attendance monitoring.

Table 2. layout of the strength of satisfaction from teachers who tried the device out

Respondents	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	AVG
1	5	5	5	5	4	5	5	4	5	5	4.8
2	4	4	4	4	4	5	5	4	5	4	4.3
3	5	5	5	5	5	5	5	4	5	5	4.9
4	5	5	4	4	4	4	4	4	4	4	4.2
5	5	4	5	4	4	4	4	4	4	4	4.2
6	4	5	5	5	4	5	5	4	4	4	4.5
Total											4.48333

The respondents reported that the system was easy to operate, provided accurate attendance records, and effectively automated the attendance-monitoring process. The RFID scanning mechanism successfully identified authorized users and recorded attendance information without requiring manual intervention.

Operational testing further demonstrated that the system consistently recorded attendance data and prevented duplicate attendance entries during the testing period. The attendance logs generated by the system matched the manually verified attendance records, indicating a high level of operational accuracy.

Table 3. combined approval rate of the teachers and students who tried out the device

Respondents	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Total%
1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%
2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
5	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	

DISCUSSION

The findings indicate that ClassScan was positively received by the teacher-participants, as reflected in the high evaluation ratings obtained during system testing. The overall mean score of 4.48 suggests a high level of perceived usefulness, usability, and reliability of the developed prototype.

The positive evaluation may be attributed to the integration of RFID technology, which enabled rapid and contactless attendance recording. Compared with traditional attendance procedures that rely on manual roll calls and paper-based records, the system streamlined attendance monitoring and reduced the likelihood of recording errors. These findings are consistent with previous studies that reported improvements in efficiency and accuracy through RFID-based attendance systems.

The successful operation of the prototype also demonstrates the practicality of utilizing open-source microcontroller platforms such as the ESP32 in the development of low-cost educational technologies. The integration of RFID identification, real-time clock functionality, image verification, and digital data storage provided a comprehensive solution for attendance management while maintaining affordability.

Despite these positive findings, several limitations must be considered. The evaluation involved only six teacher-participants from a single institution, limiting the generalizability of the results. Furthermore, the study focused primarily on prototype development and initial testing rather than long-term implementation. Future investigations involving larger samples, multiple institutions, and extended deployment periods are recommended to further validate the effectiveness and scalability of the system.

Overall, the results provide preliminary evidence supporting the potential of ClassScan as an efficient and practical attendance-monitoring system for educational environments.

CONCLUSION

A thorough examination of the test results indicates that ClassScan successfully fulfilled its intended purpose. The findings demonstrate that the integration of modern technology into classroom management does not necessarily require extensive financial resources or complex institutional infrastructure. By utilizing cost-effective, open-source hardware such as the ESP32 microcontroller, the researchers developed a durable and efficient attendance-monitoring device capable of operating reliably within a typical school environment.

The system's overall satisfaction rating of 4.48, as evaluated by participating teachers, suggests a high level of user acceptance and practicality. The results indicate that the system was intuitive to use, required minimal training, and integrated smoothly into existing classroom routines without causing disruptions. Furthermore, the operational testing results indicated that the system consistently performed its intended functions during the evaluation period, including attendance recording, user identification, and duplicate-entry prevention. Through automated attendance recording, the system eliminated issues such as proxy sign-ins, omitted entries, and difficulties arising from illegible handwriting, thereby improving both the accuracy and efficiency of attendance management.

Overall, these findings support the viability of ClassScan as a practical and reliable solution for classroom attendance monitoring. The study further demonstrates the potential of open-source technologies to provide affordable and effective innovations for educational institutions seeking to enhance administrative processes.

Limitations of the Study

Several limitations should be considered when interpreting the findings of this study. First, the evaluation of the ClassScan system involved only six teacher-participants from a single educational institution. As a result, the findings may not be representative of the perceptions and experiences of educators in other departments, schools, or educational settings, thereby limiting the generalizability of the results.

Second, the study was conducted within a localized classroom environment and focused primarily on the development and initial evaluation of the prototype. Consequently, the study did not assess the system's long-term performance, scalability, or effectiveness across diverse educational contexts.

Furthermore, the evaluation relied primarily on descriptive measures and user perceptions. Although the evaluation questionnaire was adapted from established frameworks, including the System Usability Scale (SUS), the Technology Acceptance Model (TAM), and ISO software quality standards, formal content validation procedures such as the computation of a Content Validity Index (CVI) were not conducted. Similarly, reliability testing of the instrument was not performed. These limitations may affect the strength of the conclusions drawn from the evaluation results.

Despite these limitations, the findings provide preliminary evidence regarding the practicality, usability, and potential effectiveness of the ClassScan system as an automated attendance-monitoring solution. Future studies involving larger and more diverse samples, formal instrument validation and reliability testing, and long-term implementation are recommended to further establish the system's effectiveness and applicability.

RECOMMENDATIONS

Based on the findings and limitations of the study, several recommendations are proposed for future research and system development. First, future studies should involve a larger number of respondents and include participants from multiple schools, departments, and educational settings to enhance the external validity and generalizability of the findings. Expanding the sample size would provide a more comprehensive assessment of user perceptions regarding the effectiveness, usability, and reliability of the system.

Second, future researchers should provide more comprehensive technical documentation of the system, including detailed descriptions of the hardware architecture, software implementation, communication protocols, and performance testing procedures. Such information would improve the reproducibility and technical rigor of the study.

Third, validation and reliability testing of the evaluation instruments should be conducted and clearly reported to strengthen the credibility of the findings. Future studies should also incorporate more advanced statistical analyses, complete data tables, and comparative performance indicators to provide a more robust evaluation of the system.

Finally, future research may compare ClassScan with existing attendance-monitoring technologies, such as biometric, QR code-based, and cloud-based attendance systems, to determine its relative advantages and limitations. Longitudinal studies are likewise recommended to assess the long-term effectiveness, sustainability, user acceptance, and operational performance of the system in actual educational environments.

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