ATTENDANCE TRACKING SYSTEM MOBILE APPLICATION THAT USES BLUETOOTH SENSING TECHNOLOGY

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A PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY OF UGANDA CHRISTIAN UNIVERSITY

May,2025

UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

Leading to a project report in Partial Fulfillment of the Requirements for the Award of the Degree of Bachelor of Science in Information Technology of Uganda Christian University.

Supervisors:

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19th May, 2025.

DECLARATION

We, Akansasira Isacc, Mugwisagye Timothy, Nakate Hildah, do here by declare that this project report is our original work and has not been published or submitted for any other degree award at any other university before.

Registration number: S21B13/075

Sign :.....

Date: 19th May,2025.

Registration number: **S21B13/020**

Sign: …….....

Date: 19th May,2025.

Registration number: **S22B13/015**

Sign :.....

Date: 19th May,2025.

APPROVAL

This project report has been submitted for examination with the approval of the following supervisors.

Sign: 

Date: 19/05/2025

Mr. Solomon Opio

Department of Computing and Technology

Uganda Christian University

Signed: _____

Date: _____

Mrs. Mukalere Justine

Department of Computing and Technology

Uganda Christian University

DEDICATION

This project report is dedicated to the Almighty God for granting us the strength, knowledge, and perseverance to complete this work.

I also dedicate this work to my beloved parents and family, whose constant prayers, support, and encouragement have been the backbone of my academic journey. Their belief in me has been my greatest motivation.

Finally, I dedicate this project to students, educators, and technology innovators who continually seek to enhance the efficiency and reliability of academic systems through smart, automated solutions.

ACKNOWLEGMENT

I would like to express my sincere gratitude to Mr. Opio Solomon and Mrs. Mukalere Justine, my project supervisors, for their continuous support, invaluable guidance, and encouragement throughout the development of this project. Their insight and expertise played a crucial role in the successful completion of this work.

My heartfelt thanks go to the academic and technical staff of the Department of Department of computing and technology,Uganda Christian University, for their assistance and for providing the resources and conducive environment necessary for this project.

I am also thankful to my fellow students and friends who contributed their ideas and gave feedback during various stages of the project development. Your collaboration is deeply appreciated.

Lastly, I extend my profound appreciation to my family for their patience, moral support, and unconditional love throughout the entire duration of this project.

ABSTRACT

This project focuses on the development of a mobile-based Attendance Tracking System using Bluetooth sensing technology to automate and streamline attendance recording. The system detects Bluetooth-enabled devices within a set range and automatically marks attendance when a registered user is nearby. It is developed using React Native, Bluetooth Low Energy API, FireBase Django , Node Js, Firestore, and Firebase], the app includes key features such as real-time tracking, automatic check-in/out, and an admin dashboard for record management. This method reduces manual errors, saves time, and prevents proxy attendance. Testing showed reliable performance and efficient data handling, proving it to be a practical solution for institutions and workplaces.

TABLE OF CONTENT

Declaration ……2

Approval……3

Dedication……3

Acknowledgement……4

Abstract……4

Chapter 1

1.0 Introduction……..7

1.1 Background……..7

1.2 Problem Statement ……7

1.3 Project Aim and Objectives ……8

Chapter 2

2.1 Literature Review ……9

2.2 Key concepts…….... 9

2.3 Tools and Technologies……9

2.4 Step-by-Step Process of the System……..9

Chapter 3

3.1 Research and Methodology……..12

3.2 Planning and Requirement Gathering…….……..12

3.3 Comparative Analysis……12

3.4 Experimental Testing……..……12

3.5 Iterative Development……..……..12

3.6 Flow chart……..13

CHAPTER 4

4.1 Analysis and Design……14

4.2 Description of the work done……..14

4.3 System Design……..15

4.4 Implementation……16

4.5 Testing and Evaluation……..16

4.6 Architecture……16

4.7 Challenges faced and Solutions……17

CHAPTER 5

5.1 Result and discussion……19

5.2 Outcomes of the Project……..….19

Chapter 6

5.1 Conclusion……20

5.2 References……20

5.3 Websites……21

5.4 Reports……22

5.5 Conference Papers……..22

5.6 Apendicies……22

5.7 Workplan……38

INTRODUCTION

Background

At institutions such as Uganda Christian University, students and Lecturers have said that poor attendance is a growing concern, negatively impacting academic performance. Traditional attendance tracking methods in educational institutions and workplaces are often manual, time-consuming, and prone to error. According to the Uganda Bureau of Statistics (UBOS), over 80% of schools and small-to-medium enterprises (SMEs) still rely on non-digital attendance methods (UBOS Education & Labour Survey, 2023). The Ugandan government, through initiatives like the National Development Plan III, is promoting ICT adoption in schools and public service sectors. This may be due to the growing emphasis on digital recordkeeping and automated systems to improve efficiency and transparency.

There is increasing smartphone usage, especially among students and employees in urban areas with increasing adoption of mobile apps for services like mobile money, education, and health. Uganda has a mobile penetration rate of 67% (UCC 2024 Report), with over 25 million mobile subscriptions. However, there remains a gap in simple, efficient mobile-based attendance tracking solutions tailored for the local context.

In the digital age, automated and wireless technologies enhance accuracy and efficiency. Most smartphones in Uganda, even low-end ones, support Bluetooth 4.0 and above, making Bluetooth-based solutions feasible and low-cost.

Problem statement

At Uganda Christian University (UCU), the current methods for tracking student attendance are outdated and inefficient. A survey conducted found three out of every five students saying that student poor performance is due to poor attendance. Attendance is manually recorded, either through roll calls or sign-in sheets, which leads to significant challenges in terms of accuracy, time management, and security. Teachers and Human Resource managers spend an estimated 15–30 minutes per day manually recording attendance (Uganda Teachers' Association, 2023). These manual processes are prone to human error, such as incorrect data entry, missed attendance, or miscommunication regarding student presence. The time spent on manual attendance tracking distracts from valuable instructional time and places unnecessary administrative burden on faculty and staff. While biometric and RFID systems are available, installation and maintenance costs are prohibitive for many Ugandan institutions (estimated at UGX 4–7 million per setup).

Furthermore, A 2022 survey by Makerere University found that over 25% of university students admitted to signing attendance on behalf of absent colleagues. The risk of proxy attendance, where students may mark others as present, leads to falsified records. As the student population at UCU continues to grow, the limitations of the current system become more apparent. The lack of automation and real-time data tracking complicates the process of generating attendance reports, making it difficult for both faculty and administrators to monitor student participation effectively. The inefficiency of the existing system not only hampers operational productivity but also raises concerns about the accuracy and integrity of attendance data. In light of these challenges, there is an urgent need for a modern, reliable, and automated solution that will streamline attendance tracking, improve accuracy, and reduce the administrative workload.

Objectives of this project

The General objective of this project is to design and implement an efficient mobile-based attendance tracking system that leverages Bluetooth sensing technology to automatically detect and record user presence within designated areas, thereby improving the accuracy, efficiency, and reliability of attendance management processes.

The specific objectives are as follows:

To automate the attendance recording process by utilizing Bluetooth proximity detection, thereby reducing reliance on manual methods.

To enhance the accuracy and reliability of attendance data by minimizing human errors and preventing proxy entries.

To develop a user-friendly mobile application capable of detecting registered Bluetooth devices within a specific range and logging attendance automatically.

To create an administrative panel for authorized personnel to monitor, manage, and export attendance records in real time.

To ensure secure and centralized data storage, incorporating user authentication to maintain the integrity and confidentiality of attendance data.

To provide a contactless, time-efficient solution suitable for use in educational institutions, offices, and other organizational settings.

LITERATURE REVIEW

Accurate and efficient attendance tracking is essential in education, corporate offices, and event management. Traditional attendance tracking methods, such as paper roll calls, are inefficient, prone to errors, and time-consuming. The lack of an automated system can make it difficult to monitor trends, enforce accountability, and intervene early for at-risk students. To address this, an integrated, real-time attendance tracking system is needed. This system will enhance accuracy, streamline record-keeping, and provide valuable insights for both students and faculty. By improving attendance monitoring, it will contribute to better student engagement and academic performance

Key Concepts

The system operates by having students' smartphones, with Bluetooth enabled, automatically detected when they enter the classroom. Each device's unique identifier is recognized by the instructor's device or a central receiver, confirming the student's presence without manual intervention. This approach ensures a seamless and efficient attendance recording process.

Tools and Technologies used

React Native

Bluetooth Low Energy API

Node. Js/ Firebase/Django

Firebase Firestore/ My Sql

Outcomes

The implementation of the Bluetooth-Based Attendance Tracking System demonstrated significant improvements in attendance management.

Step-by-Step Process of the System

User Login

Users (students or employees) download the mobile application and log in with their personal details and device information as provided by the administration.

Each user is assigned a unique ID linked to their Bluetooth device.

Admin Setup

The administrator (teacher or supervisor) logs in to the admin panel.

The Bluetooth or host device is activated in the designated area (e.g., classroom or office).

Bluetooth Scanning Initiated

When a session begins, the system starts scanning for nearby registered Bluetooth devices within a predefined radius.

The scanning is done using Bluetooth Low Energy (BLE) to detect active devices.

Device Detection and Verification

When a user's device is detected, the system verifies its identity against the database.

The user's presence is confirmed only if the detected device matches a registered user.

Automatic Attendance Logging

Once verified, the user's attendance is automatically marked for that session.

Time of entry and exit is logged in real time.

Data Sync and Storage

Attendance data is synced to a secure cloud database.

Both users and administrators can view attendance records through the app/dashboard.

Admin Review and Report Generation

The admin can monitor live attendance, export records, and generate reports for specific dates, users, or sessions.

Limitations of the System

Range dependency: Bluetooth detection is limited to a specific radius, and signal interference may affect accuracy.

Device requirement: Users must have a Bluetooth-enabled smartphone and keep Bluetooth turned on during attendance sessions.

Battery consumption: Continuous Bluetooth scanning can have an impact on battery life for both host and user devices.

Security constraints: Although the system verifies device identity, it may still be vulnerable to spoofing or device sharing without additional authentication layers.

Scalability: Performance may vary in large-scale deployments or environments with multiple overlapping Bluetooth signals.

Platform dependency: Initial implementation may be limited to a single mobile platform depending on development resources.

RESEARCH AND METHODOLOGY

To ensure a well-informed and effective system design, both qualitative and quantitative research methods were employed throughout the development of this project.

User Requirements Gathering

Informal interviews and surveys were carried out among potential users, such as students, teachers, and office staff, to identify common challenges in existing attendance systems and expectations from an automated solution.

Comparative Analysis

Similar systems and applications were analyzed for functionality, user experience, and technology stack. This helped in identifying key features to include and avoid in the proposed system.

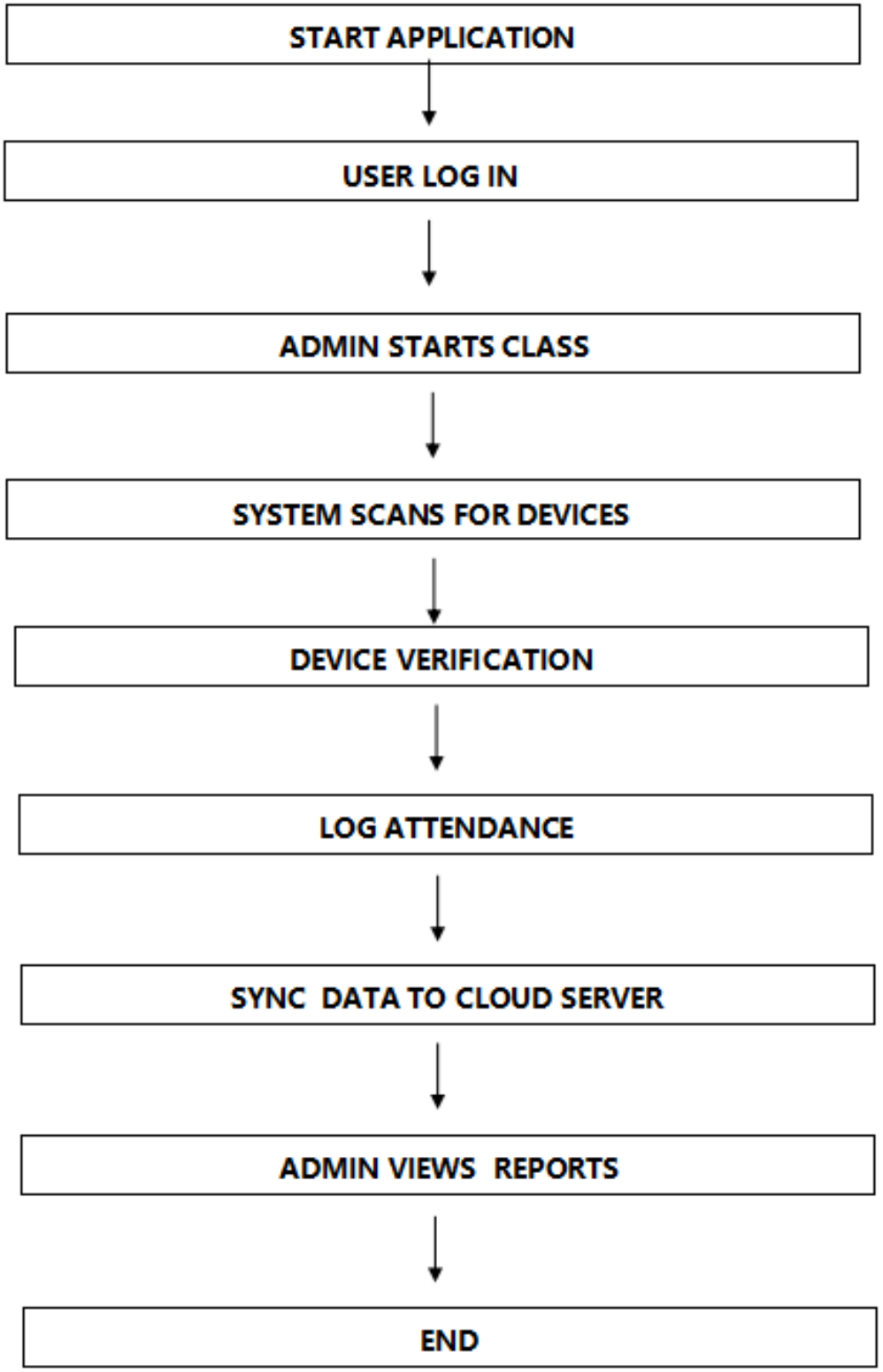
Experimental Testing

Prototypes were tested in controlled environments to measure Bluetooth range accuracy, device detection reliability, and response times. Several test cases were conducted to simulate real-world classroom or meeting conditions.

Iterative Development (Agile Approach)

The project followed an iterative development cycle. Each phase—design, development, and testing—was refined based on continuous feedback and testing results, ensuring alignment with user needs and technical feasibility**.**

FLOW CHART



ANALYSIS AND DESIGN

Description of the work done.

Requirements Gathering:
Conducted consultations with stakeholders to identify limitations of existing attendance systems and establish functional requirements for the new system.

System Design:
Developed the system architecture, including database schema and user interface prototypes, emphasizing user-friendliness and efficient data management.

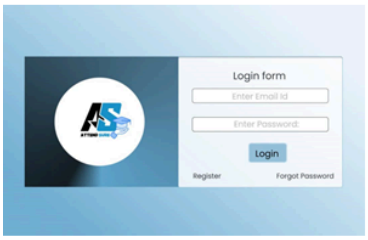
Technology Selection:
We chose React Native for mobile development and Firebase/Node. Js / Django for backend services, ensuring scalability and real-time data synchronization.

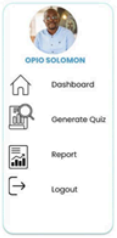
Application Development:
Implemented frontend interfaces and backend functionalities, integrating Bluetooth Low Energy (BLE) protocols for device detection and automatic attendance logging.

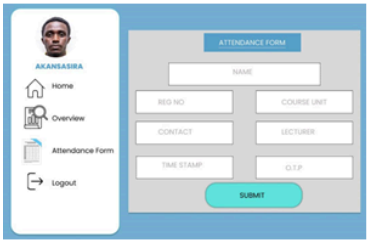
Testing and Validation:
Performed unit and integration testing to verify system reliability, followed by user acceptance testing to ensure the application met stakeholder expectations.

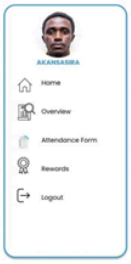
Deployment and Documentation:
Deployed the application in a controlled environment and compiled comprehensive documentation covering system functionalities, user guides, and maintenance procedures.

System Design









IMPLEMENTATION

App features

User login

Background bluetooth scanning

Signal filtering and processing

Attendance confirmation with timestamps

View attendance history

Backend

Restful API endpoints

Secure Json Web Token (JWT) based authentication

Attendance data stored with user and time metadata

Admin role to fetch and filter attendance logs.

Testing and Evaluation

In the Testing and Evaluation phase of the Bluetooth-Based Attendance Tracking System project, a series of assessments were conducted to ensure the system's functionality, performance, and user satisfaction. The key components of this phase included:

Testing

Unit Testing: Individual components of the system, such as the Bluetooth detection module and user interface elements, were tested in isolation to verify that each functioned correctly.

Integration Testing: Following unit testing, integration testing was performed to ensure that combined components operated seamlessly together, focusing on data flow between modules.

System Testing: The complete system was tested in an environment that simulated real-world conditions to validate overall behavior and compliance with specified requirements.

User Acceptance Testing (UAT): End-users, including instructors and students, participated in testing the system to confirm that it met their needs and expectations, providing feedback on usability and functionality.

Evaluation

Performance Evaluation: The system's responsiveness and reliability were assessed by measuring the time taken to detect devices and record attendance under various conditions.

Accuracy Assessment: The precision of the Bluetooth detection mechanism was evaluated to ensure correct identification and recording of student devices within the designated range.

User Feedback: Surveys and interviews were conducted with users to gather insights into their experiences.

Architecture

The system consists of three primary components. Mobile App (Client) that is installed on the user's smartphone to detect bluetooth and communicate with the backend server. Bluetooth Low Energy, using key concepts of bluetooth sensing, mobile devices can communicate via Bluetooth for peer to peer data exchange. Backend server which handles data processing, authentication and database storage.

Challenges faced and Solutions

1. False registration of student's attendance in the Bluetooth-based tracking system, we are implementing the following security measures:

Multi-Factor Authentication (MFA): Require users to verify their identity through multiple factors, such as:

Something they know: A registration number, password or PIN.

Something they have: The registered mobile device.

Something they are: Biometric data like fingerprints or facial recognition. Combining these factors enhances security by ensuring that possession of the device alone is insufficient for authentication.

Device Binding: Associate each user's account with a unique device identifier, such as the International Mobile Equipment Identity (IMEI) number. This ensures that only the registered device can be used to mark attendance, preventing unauthorized devices from being used.

Geofencing: Implement geofencing to restrict attendance marking to specific geographic locations. This ensures that users can only register attendance when they are within the designated area, adding an additional layer of verification.

Regular Audits and Monitoring: Conduct periodic audits of attendance records and monitor for anomalies, such as multiple attendances from the same device or patterns indicative of fraudulent behaviour. Prompt investigation of such anomalies can deter and detect misuse.

2. Addressing the limitation of Bluetooth's capacity to connect with only seven devices simultaneously is crucial for the effective operation of a Bluetooth-based attendance tracking system. To overcome this constraint, consider implementing the following strategy:

Deploy Multiple Central Devices:

Distribute the connection load by deploying multiple central devices (masters) within the environment. Each central device can manage its own set of peripheral devices (slaves), effectively multiplying the number of devices that can be connected simultaneously.

RESULTS AND DISCUSSION

The implementation of the Bluetooth-Based Attendance Tracking System yielded several notable outcomes:

Outcomes of the Project

98% accurate detection within 5 meters

Seamless data sync under moderate load

Low battery consumption due to bluetooth optimisation

Enhanced Efficiency: The system significantly reduced the time required for attendance marking by automating the process, thereby allowing more instructional time during sessions.

Improved Accuracy: By minimizing human intervention, the system decreased errors associated with manual attendance recording, leading to more reliable data.

Real-Time Monitoring: Administrators gained the ability to monitor attendance records in real-time, facilitating prompt interventions when necessary.

User Convenience: Utilizing students' existing smartphones for attendance eliminated the need for additional hardware, offering a seamless and user-friendly experience.

Scalability: The system demonstrated adaptability to various class sizes and environments, showcasing its potential for broader institutional implementation.

CONCLUSION

The Bluetooth attendance tracking system proves to be an efficient and accurate solution for automated attendance tracking. While it performs well in terms of accuracy and efficiency, addressing signal interference, battery consumption, and privacy concerns can further enhance its usability. Once approved, improvements will focus on refining detection algorithms, expanding system integrations, and strengthening data security to ensure a seamless experience for users.

References

Books:

Introduction to Bluetooth Technology by S. J. Hemminger (2005). This book provides a foundational understanding of Bluetooth technology and its various applications, including proximity-based systems like the Bluetooth Beacon technology used in this project.

Journal Articles.

Zhou, M., Zhang, J. (2018). "Design and Implementation of a Bluetooth-Based Smart Attendance System." Journal of Wireless and Mobile Networks, 23(3), 45-58. This article discusses the use of Bluetooth technology in creating automated attendance tracking systems, focusing on design principles, system architecture, and performance evaluations.

Patel, R., Mehta, S. (2019). "A Comprehensive Study on the Use of Bluetooth Low Energy Beacons for Indoor Positioning and Tracking." International Journal of Computer Science and Technology, 10(4), 134-142. The article examines Bluetooth Low Energy (BLE) beacons, their use in location-based services, and how they can be adapted for educational environments such as attendance tracking.

Websites

Bluetooth SIG. (n.d.). Bluetooth Technology Overview. https://www.bluetooth.com/what is-bluetooth-technology/ This website provides a comprehensive overview of Bluetooth technology, its development, and its applications, which is essential for understanding the technical foundation of the Bluetooth Beacon system.

Magento Ecommerce. (n.d.). Magento Ecommerce Platform. https://magento.com/ Magento offers solutions for e-commerce development and has potential integrations with other platforms, which might be useful for scaling up the mobile attendance system or integrating it into a broader academic management system.

Reports.

University of Oxford (2021). "The Role of Technology in Modernizing Higher Education Systems." This report evaluates the integration of technology in educational institutions and highlights the benefits of automation, such as attendance systems and real-time data collection.

Bluetooth Special Interest Group (2020). "Bluetooth Low Energy Beacons: Enhancing Real-Time Communication and Tracking." This report provides an in-depth look at how BLE

beacons have revolutionized various industries, particularly in applications like attendance and asset tracking, which is relevant to the proposed system.

Conference Papers.

Lee, H., Park, S. (2017). "Bluetooth Beacon-Based Indoor Navigation and Attendance Tracking System." Proceedings of the 2017 International Conference on Wireless Communications and Mobile Computing. The paper discusses Bluetooth beacon technology used for

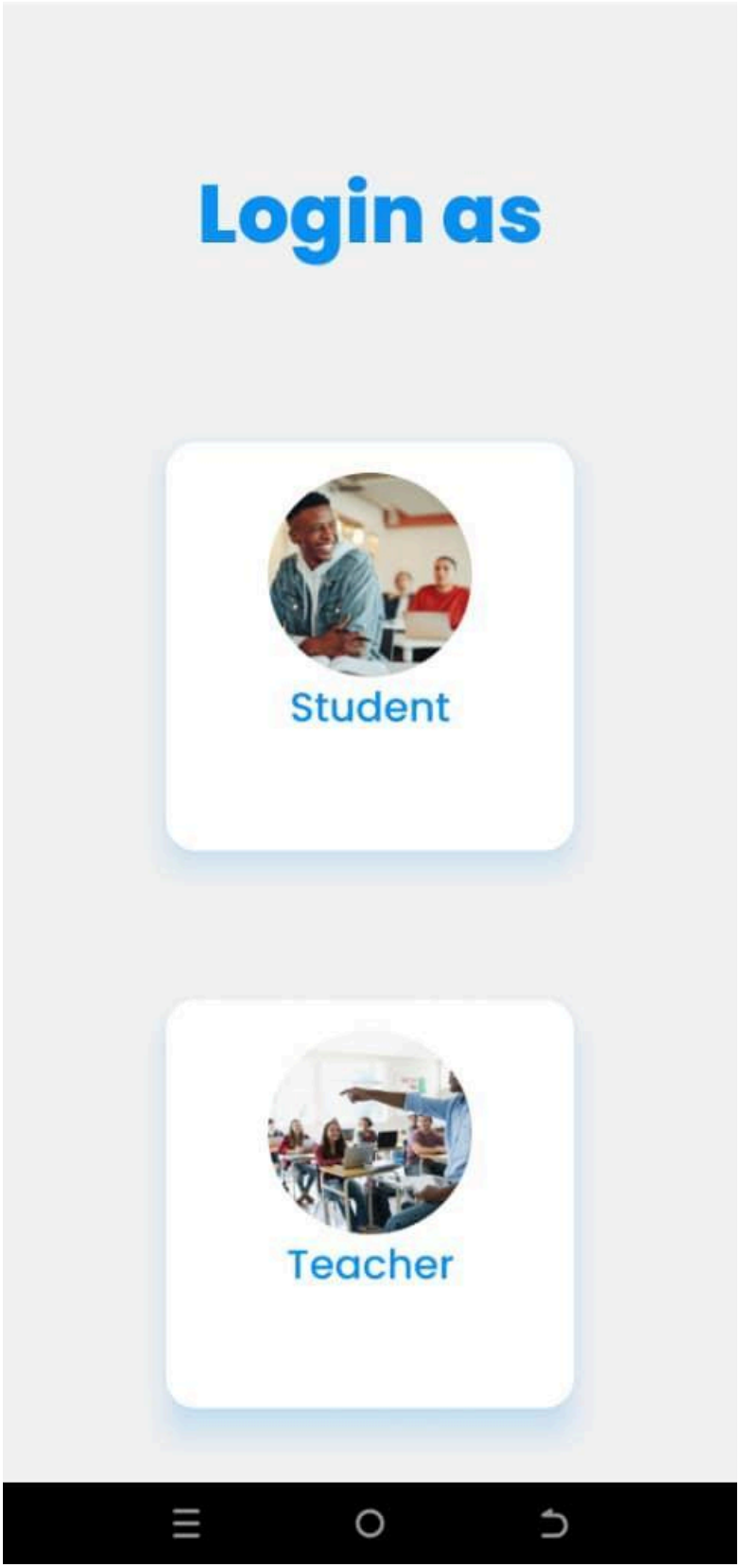
both indoor navigation and attendance tracking in universities, offering a practical approach to integrating these systems in academic environments.

Huang, Y., Chen, W. (2018). "Designing an IoT-Based Attendance System Using Bluetooth Low Energy Technology." Proceedings of the 2018 IEEE International Conference on Internet of Things and Big Data. This conference paper presents a detailed design of an IoT-based attendance system leveraging BLE technology, similar to the proposed system for UCU

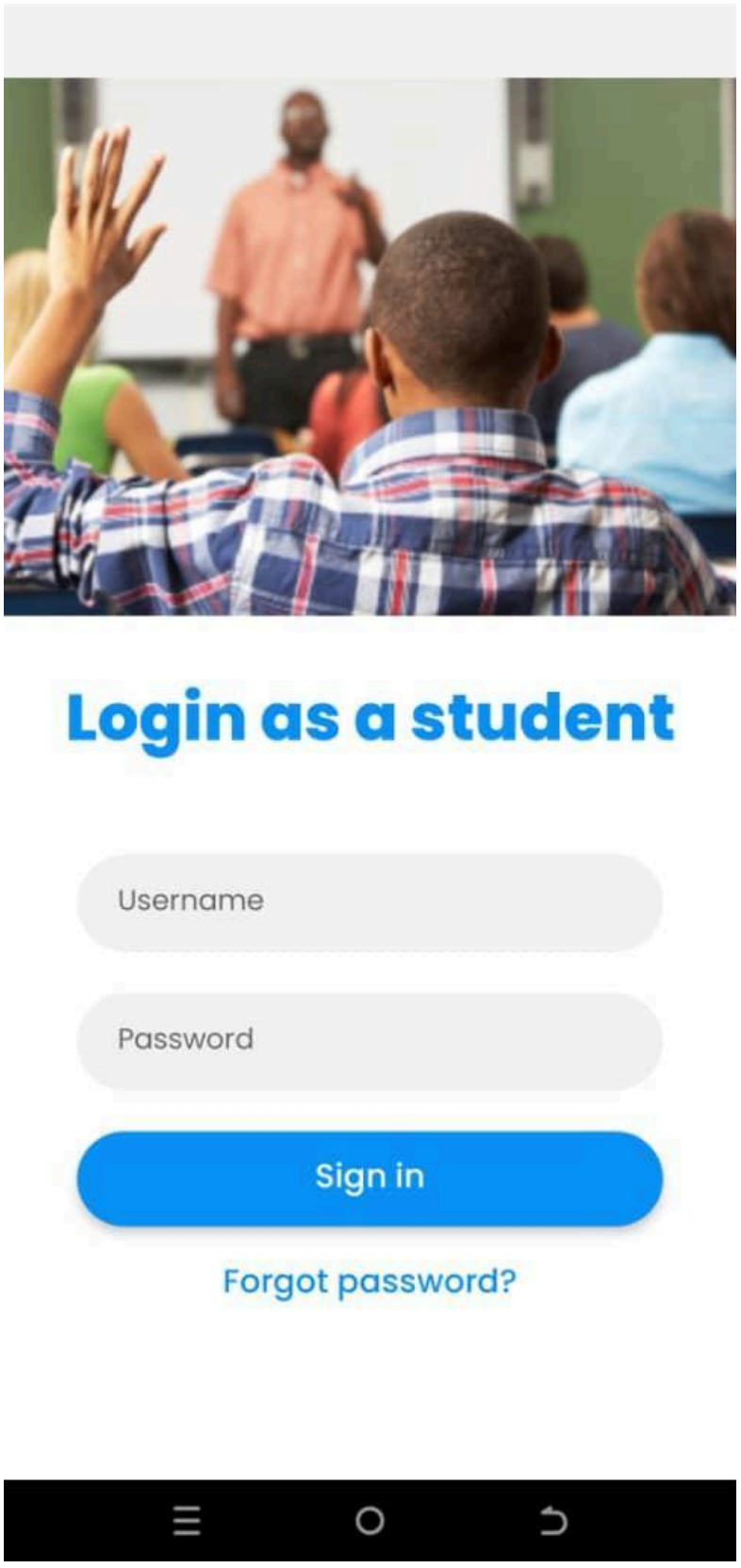
APENDECES

APPENDIX 1: IMAGES OF THE MOBILE APPLICATION

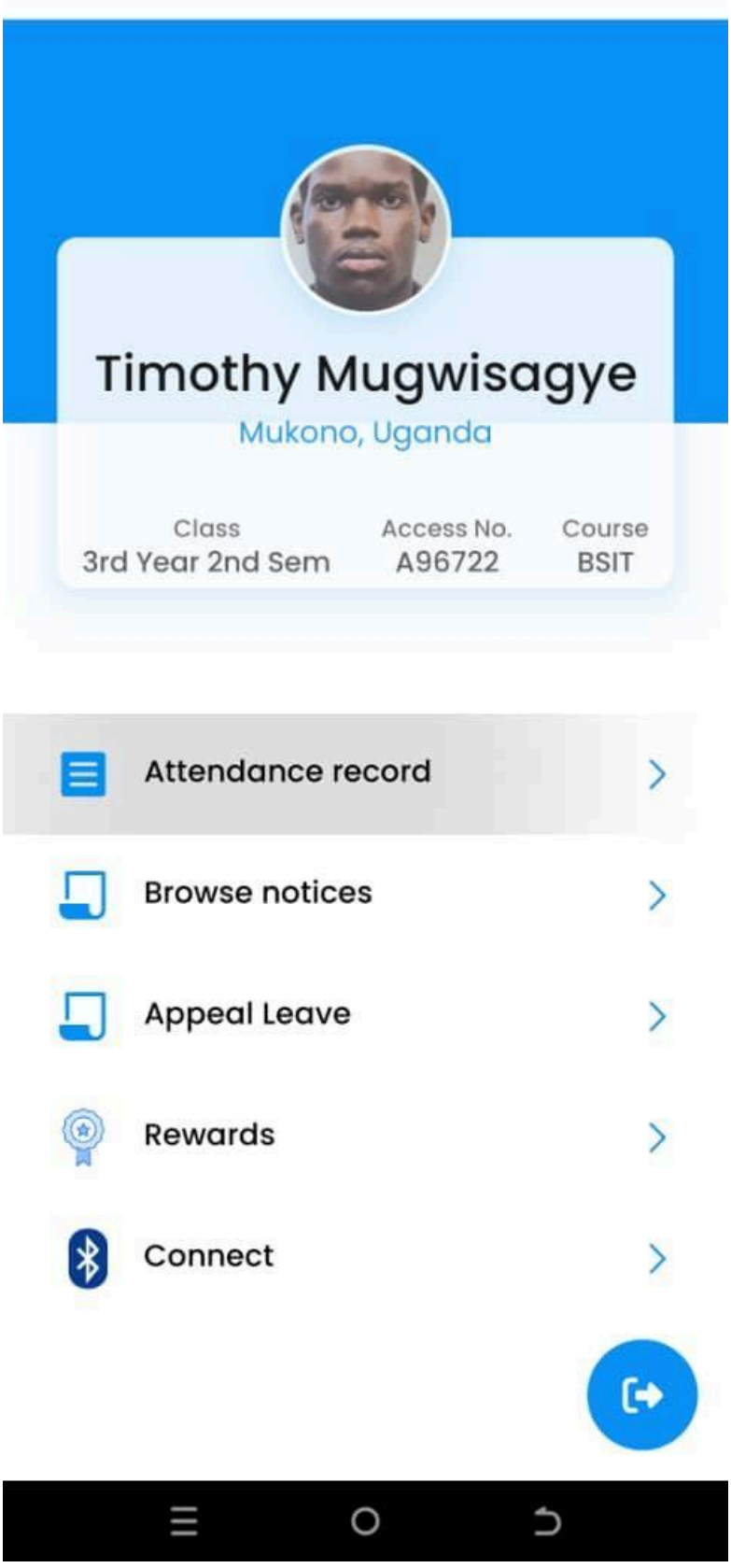
LOGIN PAGE



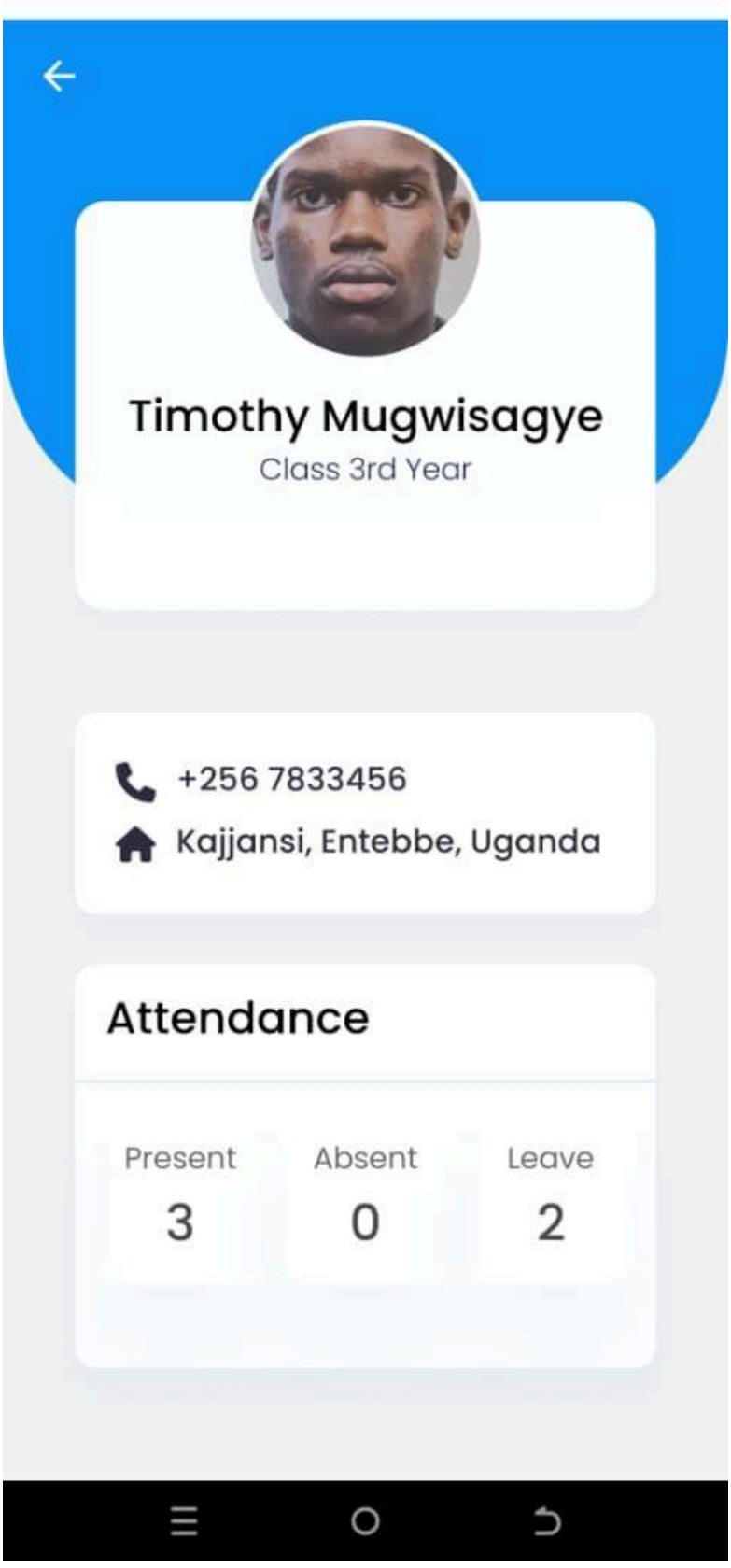
STUDENT LOGIN



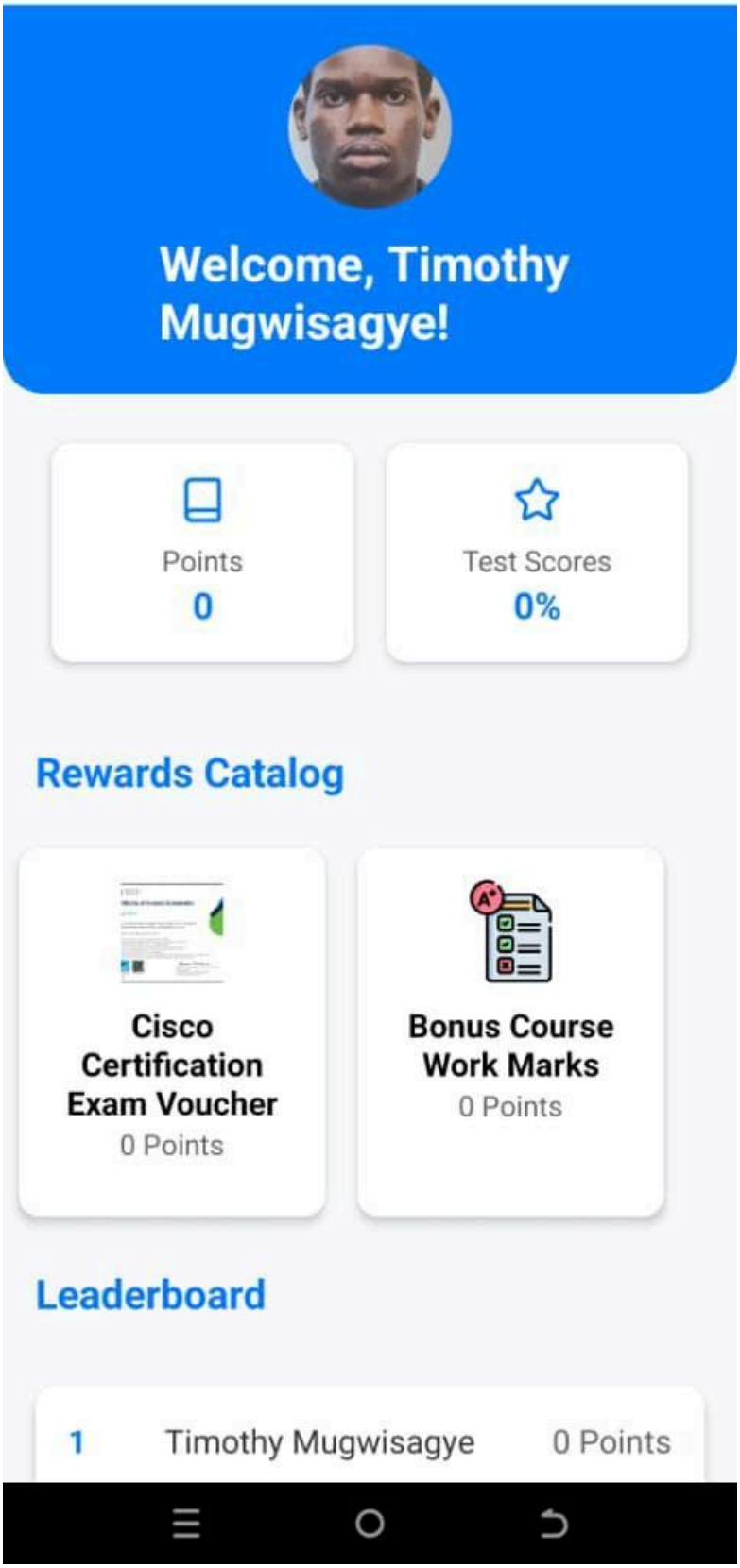
STUDENT PROFILE



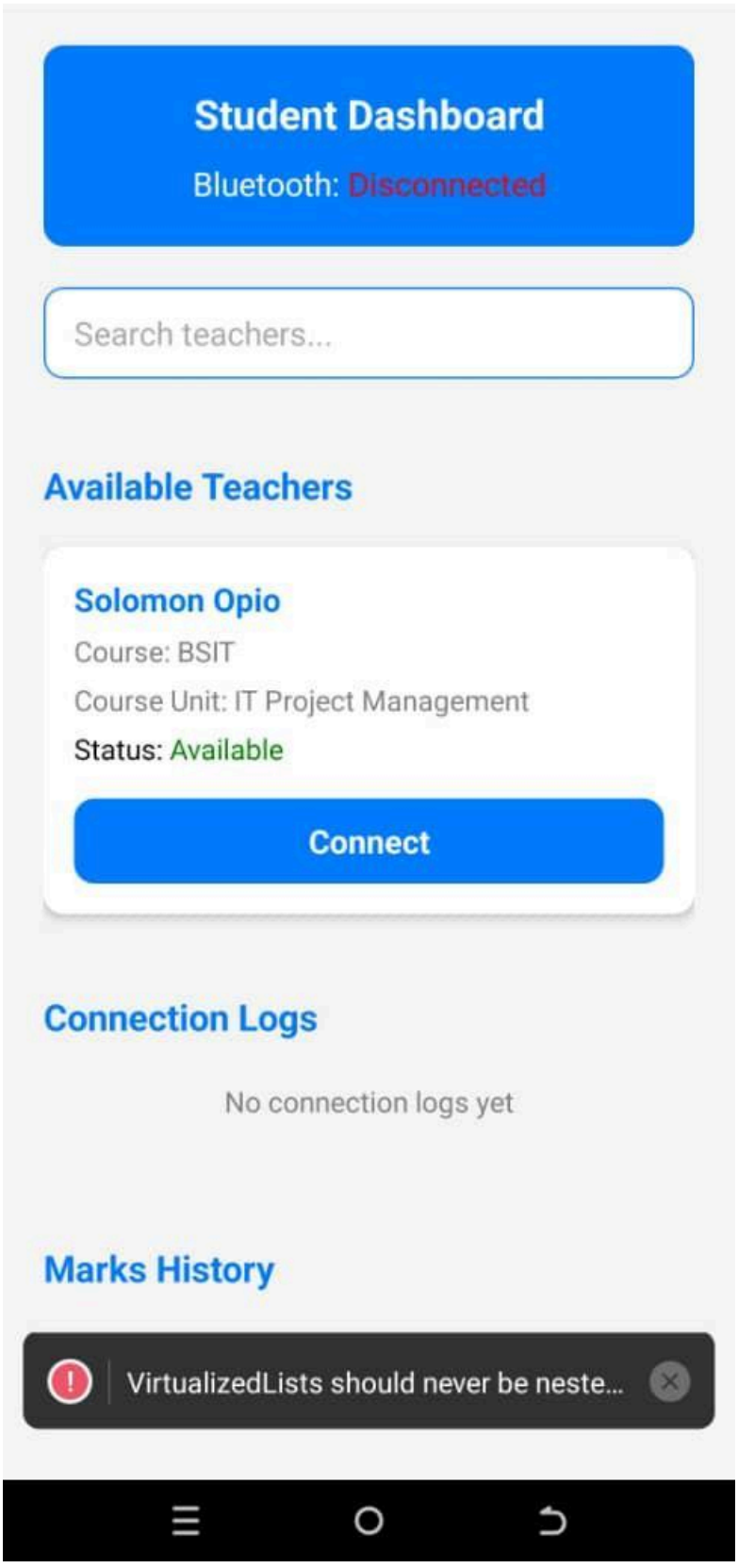
ATTENDANCE RECORD


Timothy Mugwisagye
Class 3rd Year
+256 7833456
Kajjansi, Entebbe, Uganda
Attendance
Present
3
Absent
0
Leave
2

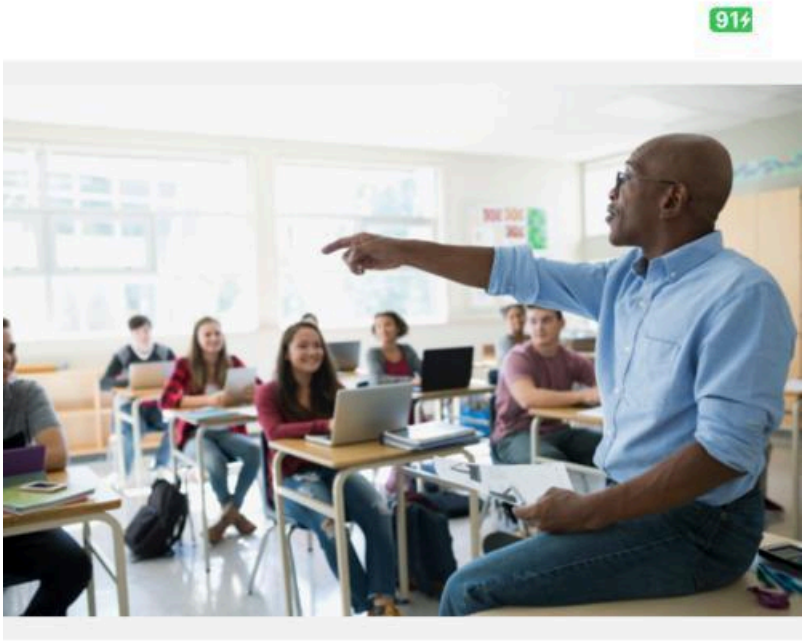
REWARD PAGE



STUDENT BLUETOOTH PAGE



TEACHER LOGIN PAGE



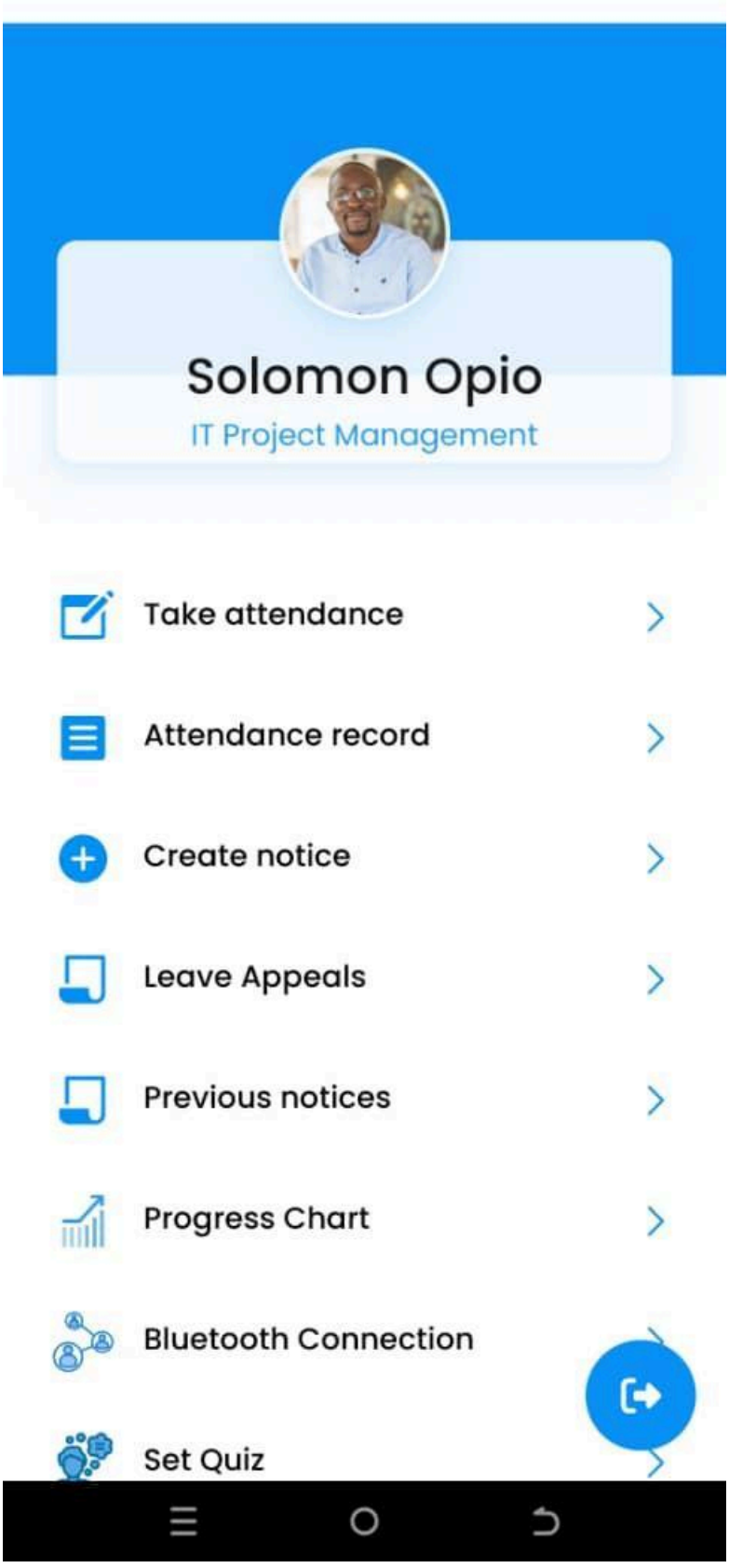
Login as a teacher

teacher

Sign in

Forgot password?

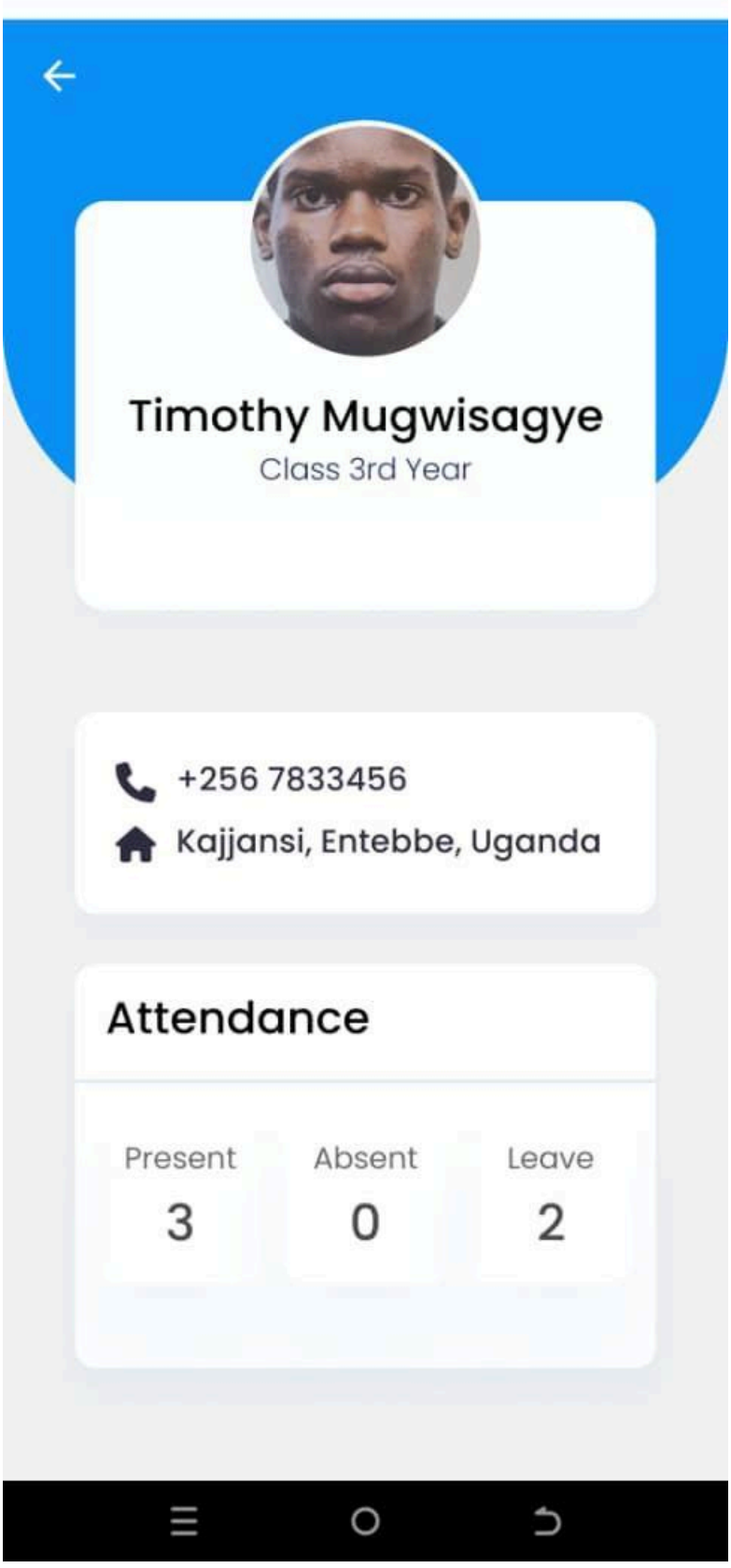
TEACHER PROFILE



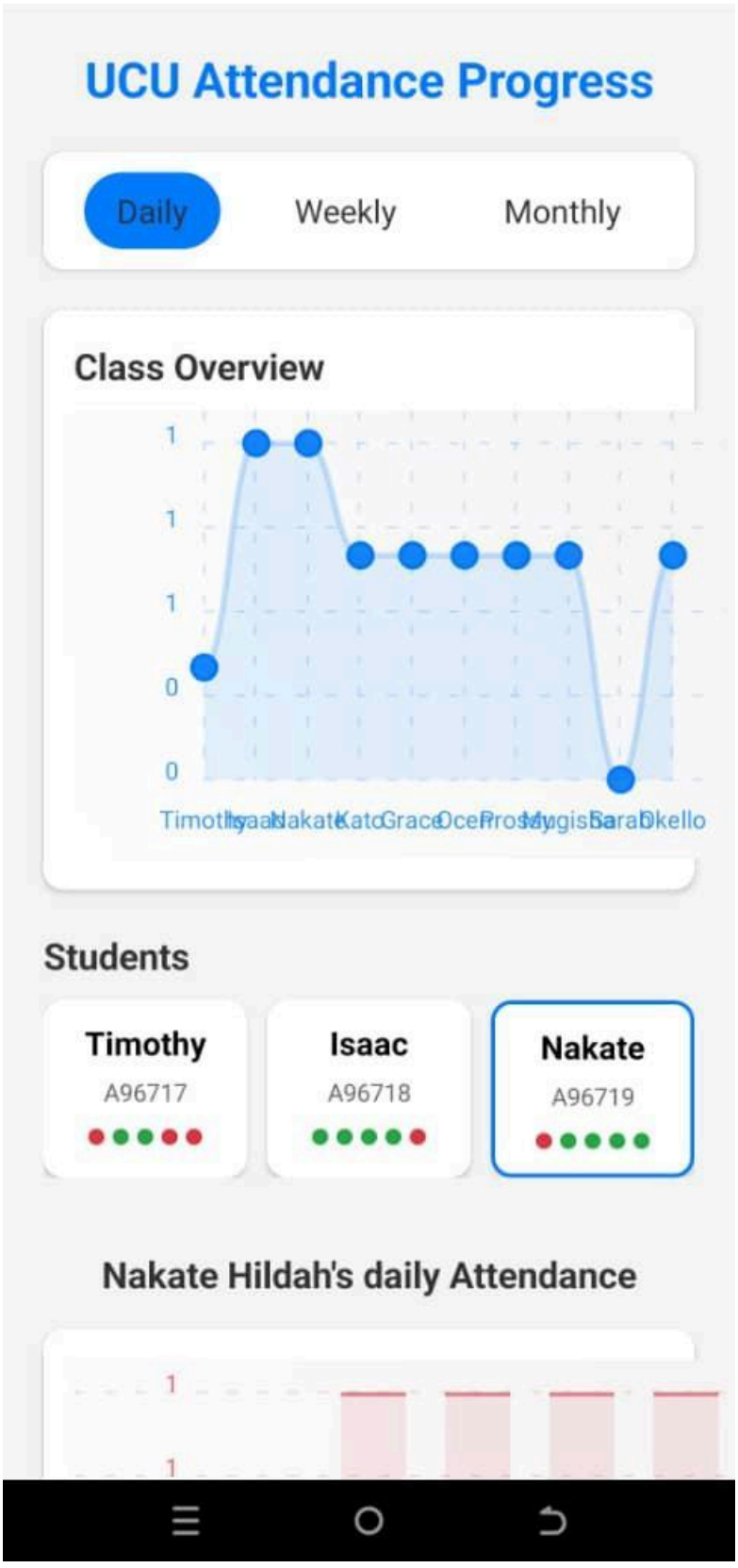
ATTENDANCE MARKING PAGE

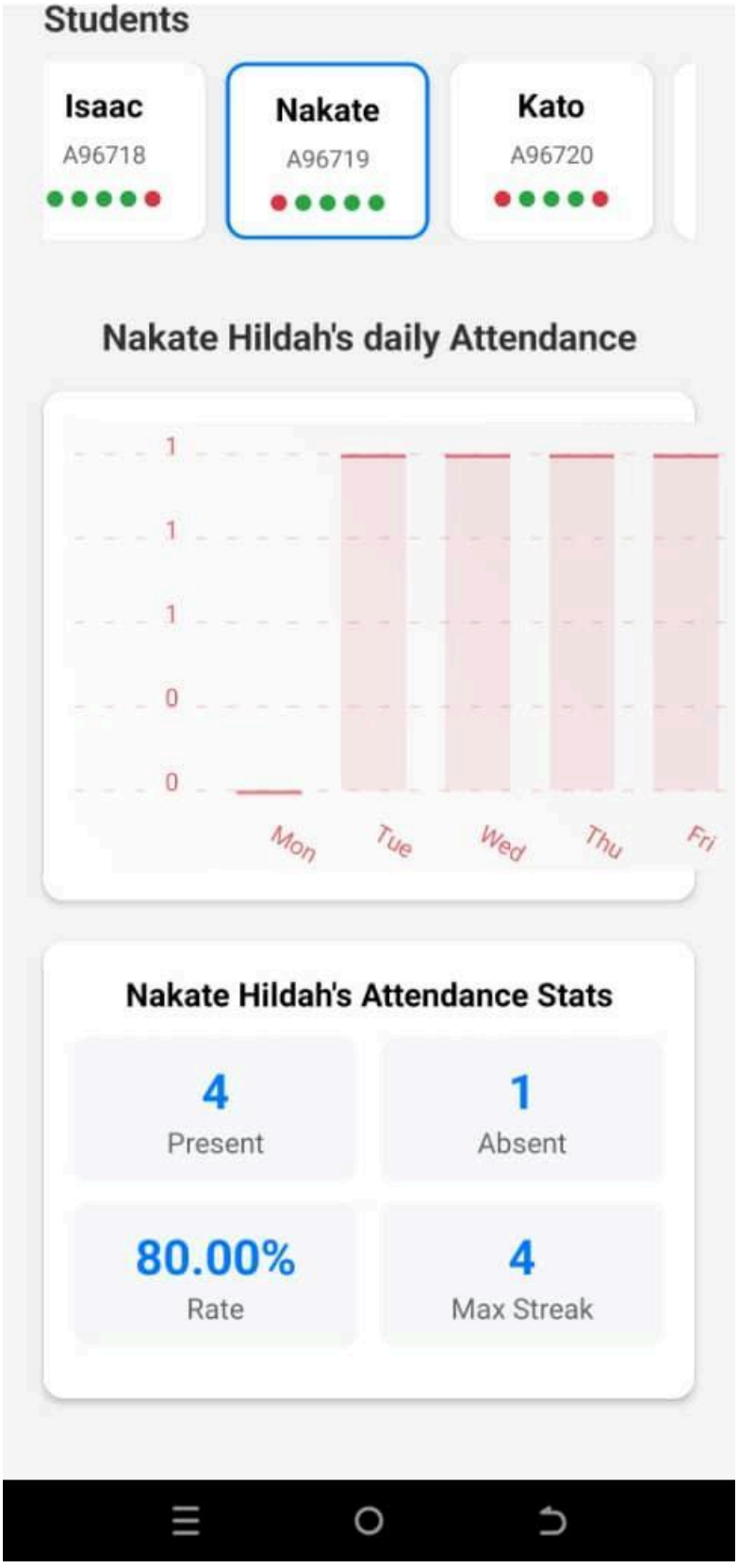
STUDENT RECORDS


Attendance record
Timothy Mugwisagye
Access No. A96722

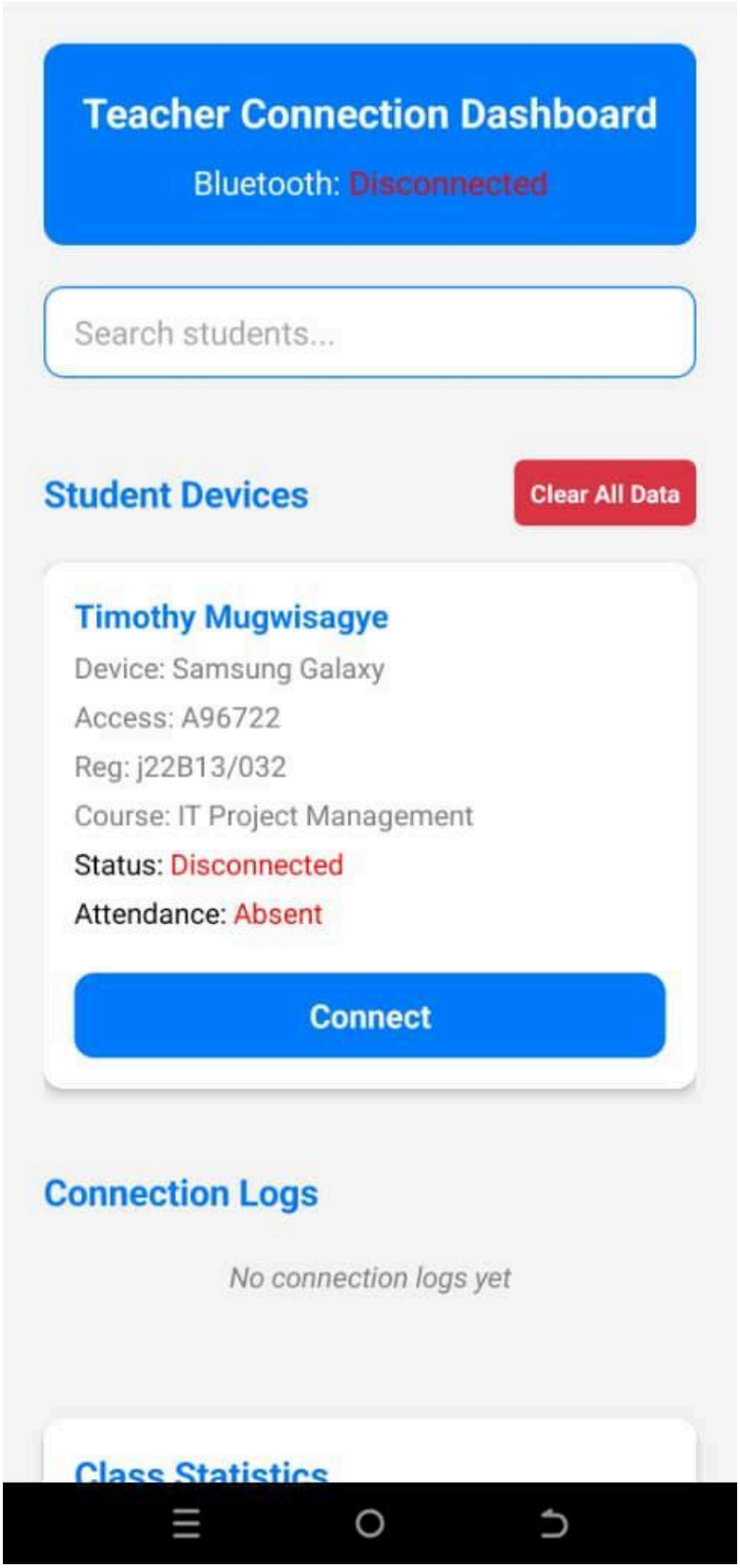


PROGRESS REPORTS PAGE

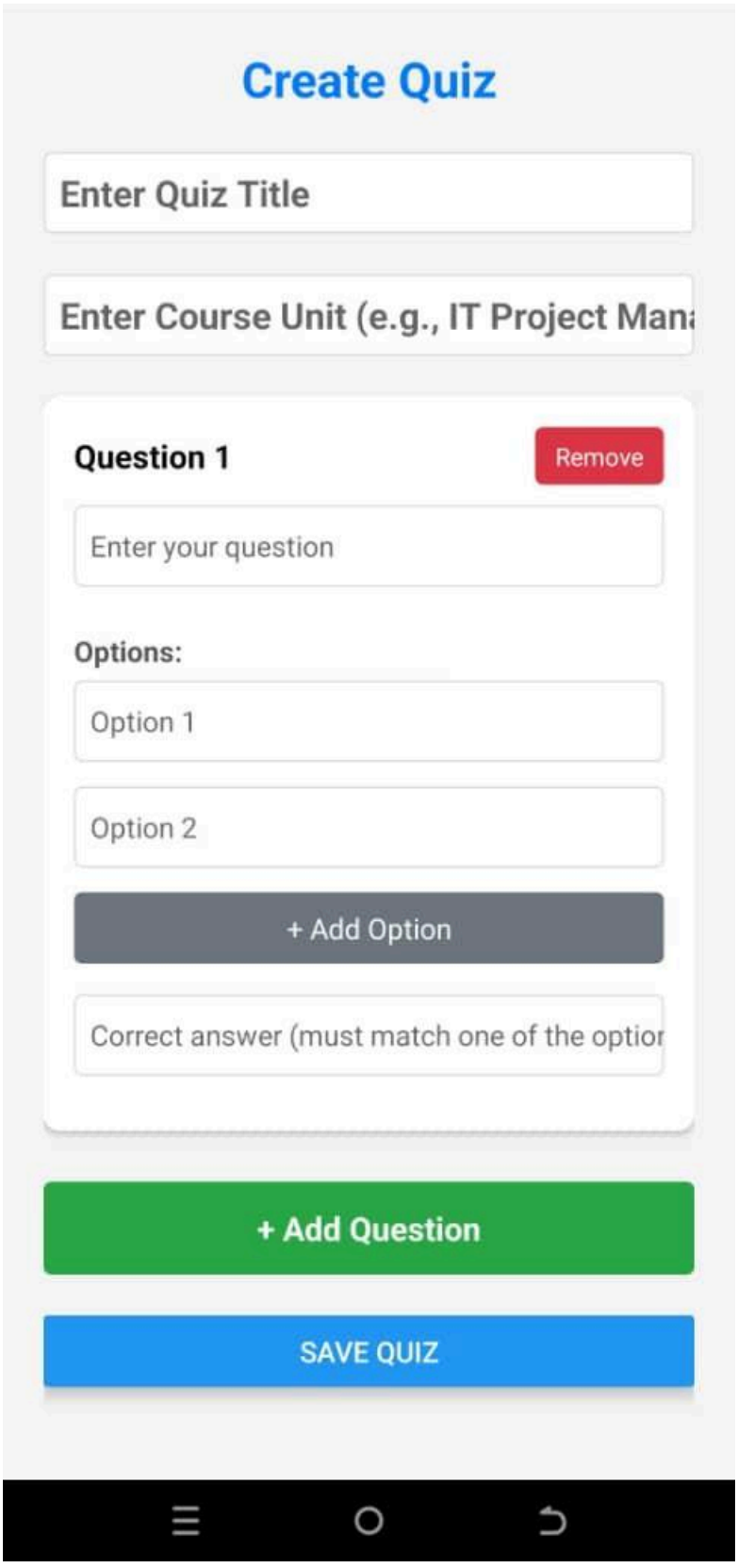

UCU Attendance Progress
Daily
Weekly
Monthly
Class Overview
1
1
1
0
0
Students
Timothy
A96717
Isaac
A96718
Nakate
A96719
Nakate Hildah's daily Attendance
1
1



TEACHER BLUETOOTH PAGE


Teacher Connection Dashboard
Bluetooth: Disconnected
Search students...
Student Devices
Clear All Data
Timothy Mugwisagye
Device: Samsung Galaxy
Access: A96722
Reg: j22B13/032
Course: IT Project Management
Status: Disconnected
Attendance: Absent
Connect
Connection Logs
No connection logs yet
Class Statistics

QUIZ PAGE


Create Quiz
Enter Quiz Title
Enter Course Unit (e.g., IT Project Mana
Question 1
Remove
Enter your question
Options:
Option 1
Option 2
+ Add Option
Correct answer (must match one of the optior
+ Add Question
SAVE QUIZ

WORKPLAN

Click Up Link to our work plan and schedule.

https://app.clickup.com/9012819461/v/l/6-901208450921-1