Design and Implementation of a Tuition Centre Timetable and Location-Based Attendance Management System

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DOI: https://doi.org/10.51244/IJRSI.2026.1313CS024

Received: 16 August 2026; Accepted: 21 August 2026; Published: 01 September 2026

ABSTRACT

Tuition centres often manage class schedules, attendance records and announcements through paper-based processes or messaging applications, which can lead to fragmented information, scheduling conflicts and difficulty verifying students' presence. This study aimed to design and implement a centralized Tuition Centre Timetable and Location-Based Attendance Management System that brings these operational functions into a single platform. The project followed an Agile development approach comprising requirements identification, planning and design, iterative development and prototype deployment. Requirements were informed by the developer's first-hand experience as a part-time tutor and were translated into functional and non-functional specifications. The resulting prototype consists of a React and TypeScript web application for administrators, React Native mobile applications for students and tutors, an Express.js backend and Supabase services for authentication and PostgreSQL data management. The implementation provides user, subject, class, enrolment and timetable management, automated weekly session generation, conflict checking, attendance reporting and push notifications. It also incorporates geofencing to permit student check-in only when the reported device location falls within a predefined tuition centre boundary. The implementation demonstrates that these components can be integrated into a unified web and mobile architecture and made available through role-specific interfaces. However, the prototype has not undergone formal usability, performance or operational testing, so its effectiveness in reducing workload and improving attendance accuracy cannot yet be established. Overall, the project provides a functional foundation for digitizing tuition centre administration. Future work should evaluate the prototype with tuition centre stakeholders, assess location accuracy under different conditions and examine usability, security and system performance before operational deployment.

Keywords: Attendance Management, Geofencing, Mobile Application, Timetable Scheduling, Tuition Centre

INTRODUCTION

Tuition centres play an important role in supporting students' academic performance by providing supplementary education outside regular school hours. As the numbers of students, classes and academic subjects increase, tuition centre administrators face great challenges in organizing daily operations efficiently. Many small and medium-sized tuition centres continue to rely on manual administrative processes or messaging applications such as WhatsApp to distribute class schedules, record attendance and communicate important announcements. Although these approaches are simple to implement, they often result in scattered information, inconsistent attendance records and inefficient communication among administrators, tutors, students and parents.

Timetable management is one of the most common operational challenges faced by tuition centres. Class schedules shared through messaging applications can become buried within lengthy conversations, making updated timetable information difficult to locate. Schedule changes, room changes or cancellations may not reach every student promptly, increasing the possibility of missed classes and communication errors.

Administrators must also coordinate tutors, classrooms and teaching schedules manually, which increases both the likelihood of scheduling conflicts and the administrative workload.

Attendance management presents another significant challenge. Conventional methods, including paper attendance sheets and manual sign-in processes, require considerable administrative effort and are prone to duplicate entries, incomplete records and inaccurate information. More importantly, these methods cannot verify whether students are physically present when attendance is recorded. Location-aware attendance research has therefore explored geofencing and related mechanisms for verifying that users are within an authorized area when they check in (Che Fauzi et al., 2025). Without such verification, tuition centres may be unable to determine whether an attendance submission reflects physical presence at the learning venue.

Recent advances in mobile computing and location-based services have enabled organizations to integrate geolocation technologies into attendance management systems. Location-based attendance verification uses the Global Positioning System (GPS) to validate a user's reported location before attendance is recorded. Mobile push notifications can also provide timely reminders and updates that support students' engagement with scheduled activities (Mumcu & Çebi, 2025). When combined with centralized timetable management, these technologies offer a basis for strengthening attendance verification and communication within educational institutions.

To address these limitations, this study presents the design and implementation of a Tuition Centre Timetable and Location-Based Attendance Management System comprising an administrator web application, student and tutor mobile applications, and an Express.js backend integrated with Supabase Authentication and PostgreSQL. The system centralizes timetable management, class scheduling, attendance monitoring and notification services while incorporating geofencing for location-based attendance verification. Administrators can manage centres, classrooms, subjects, tutors, students, enrolments and weekly timetable sessions. Students can view personalized timetables, receive reminders and submit attendance only when located within the predefined tuition centre boundary, while tutors can view timetables and manage attendance through the mobile application.

The objectives of this study were to examine the operational challenges associated with tuition centre timetable and attendance management, develop a centralized timetable management platform, and implement a location-based attendance verification mechanism to support administrative monitoring. The study contributes a practitioner-informed design that integrates web and mobile technologies within a single prototype for tuition centre operations.

Related Work

Timetable Management Systems

Timetable management is important in educational institutions because schedules must coordinate tutors, students, classrooms, subjects and available time slots. Manual scheduling can be time-consuming and may lead to timetable conflicts or inefficient use of resources. Diallo and Tudose (2024) highlighted that automated scheduling can reduce conflicts by considering constraints such as room availability and instructor schedules. Centralized systems can also improve administrative efficiency by integrating scheduling with other management functions. Hanafiah and Ab. Aziz (2022) developed a web-based tuition centre management system that combines student and tutor registration, class scheduling, attendance reporting and other administrative activities within one platform. The proposed system therefore adopts a centralized approach that integrates timetable scheduling, room and tutor allocation, and conflict checking for tuition centre management.

Location-Based Attendance and Mobile Notifications

Location-based attendance systems use smartphone GPS information to verify whether users are physically present at a designated location before attendance is recorded. Chiang et al. (2022) demonstrated that GPS-enabled smartphones can support more efficient attendance tracking, while Eweoya et al. (2025) showed that geofencing can restrict attendance submission to users located within a predefined virtual boundary. Uddin et al.

(2014) similarly proposed comparing a user's GPS coordinates with a stored organizational location before attendance data are submitted to the system. However, GPS accuracy can be affected by environmental conditions and may be less reliable inside buildings, which requires an appropriate geofence radius to reduce incorrect validation (Chiang et al., 2022; Eweoya et al., 2025). In the proposed system, geofencing is combined with mobile notifications to support attendance verification while providing students with class reminders, timetable updates and attendance-related information (Mumcu & Çebi, 2025).

Comparison of Existing Systems

Instead of describing each existing system separately, the major features of existing solutions are summarised in Table 1.

Table 1: Comparison of Existing Systems and the Proposed System

Feature	Google Classroom	ClassDojo	TutorBird	Proposed System
Student Management	✓	✓	✓	✓
Tutor Management	✗	Limited	✓	✓
Timetable Management	Limited	✗	✓	✓
Tuition Class Management	✗	Limited	✓	✓
Attendance Recording	Basic	✓	✓	✓
Location-Based Attendance Verification	✗	✗	✗	✓
Attendance Reporting	Limited	Limited	✓	✓
Push Notifications	✓	✓	Limited	✓
Mobile Application	✓	✓	✓	✓
Web Administration	✓	Limited	✓	✓
Weekly Session Generation	✗	✗	✗	✓
Timetable Conflict Detection	✗	✗	Limited	✓

The comparison in Table indicates that the reviewed platforms focus on different aspects of educational administration. Google Classroom provides a learning management environment but does not document location-based attendance verification or comprehensive tuition centre administration (Google, n.d.). ClassDojo emphasizes communication between teachers and parents and offers limited timetable management capabilities (ClassDojo, n.d.). TutorBird provides several tuition management features but does not document an integrated location-based attendance verification mechanism or automated timetable conflict detection (TutorBird, n.d.). Consequently, the comparison identifies differences in functional coverage but does not establish that the proposed system is more effective. A future comparative evaluation should assess the proposed prototype and suitable alternatives using common criteria and testing conditions.

The proposed system integrates timetable management, attendance verification, notification services and administrative management within a centralized platform. Its design combines geofencing, weekly session generation, timetable conflict detection and centralized attendance reporting. These functions distinguish the prototype from the features documented for the reviewed platforms; their operational benefits will need to be established through subsequent evaluation.

METHODOLOGY

This study adopted an Agile software development approach to design and implement the proposed system. Agile was selected to support incremental development and refinement as the system requirements and interfaces evolved. The project comprised four main phases: requirements identification, planning and design, iterative development and prototype deployment. These phases are summarized in Figure 1.

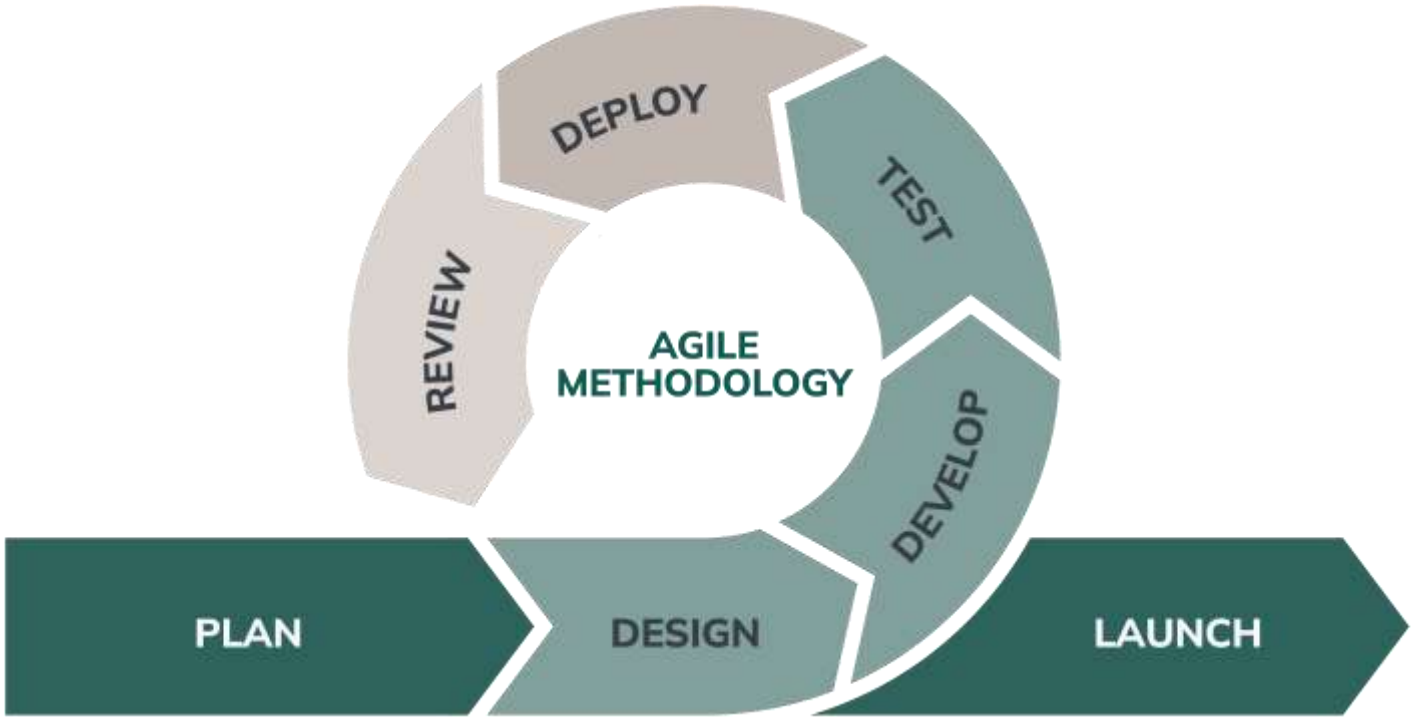


Figure 1: Agile Development Methodology

Requirements Identification

Requirements identification focused on the operational challenges associated with class timetables, student attendance and communication in tuition centres. The requirements were informed by the developer's first-hand experience as a part-time tutor, including direct exposure to existing operational workflows. This experience highlighted scattered timetable information, manual attendance recording, difficulty verifying student presence and inefficient communication of class updates. The observations were translated into functional requirements for authentication, timetable management, attendance verification, notifications and reporting. Non-functional requirements addressed security, usability, performance and data reliability. This experience-based requirements identification established the project scope and informed subsequent design decisions.

Planning and Design

During planning and design, the identified requirements were translated into the system architecture, workflows and interface designs. Use case diagrams, sequence diagrams, data flow diagrams and database designs were prepared to define interactions among administrators, tutors, students and backend services. A multi-tier architecture comprising a web application, mobile applications, an Express.js backend, Supabase Authentication and a PostgreSQL database was designed to support centralized data management and secure communication among system components. Interface prototypes were prepared before implementation. Figure 2 presents the overall system use case diagram.

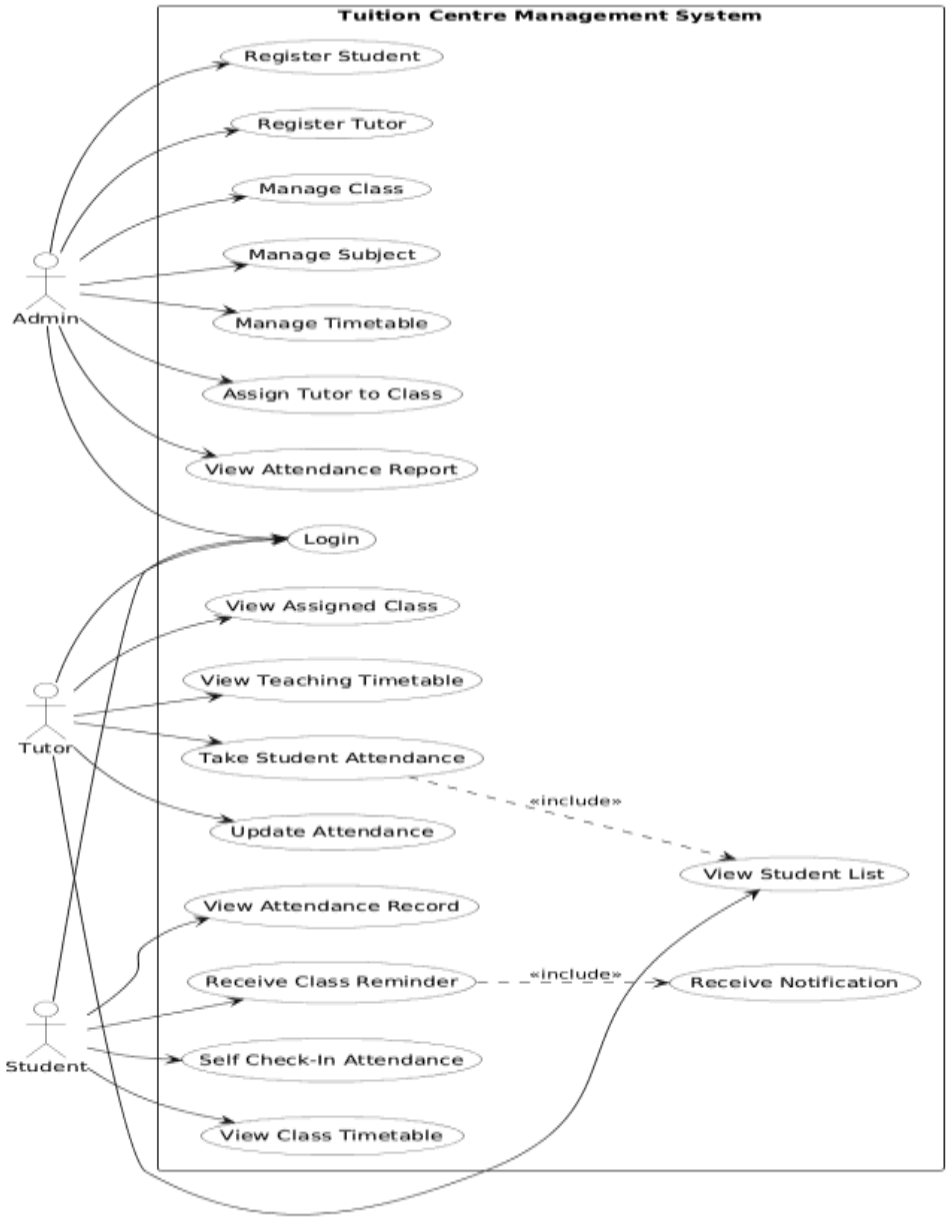


Figure 2: Overall System Use Case Diagram

Iterative Development

During iterative development, the administrator web application was implemented using React and TypeScript, while the student and tutor mobile applications were implemented using React Native with Expo. Express.js was used for the backend, and Supabase provided authentication and PostgreSQL database services. User management, timetable scheduling, attendance verification, notifications, enrolment management and reporting were developed incrementally. Integration between the frontend and backend components enabled the modules to be combined and refined across successive iterations.

Prototype Deployment

The prototype deployment phase prepared the system for demonstration in a controlled environment. The administrator application was hosted for access through a web browser and the student and tutor applications were prepared for use on mobile devices. Supabase and Express.js services were configured to support authentication, database operations and notifications. The system remains a functional prototype and has not been deployed for operational use in a tuition centre.

RESULTS

A functional prototype of the proposed system was implemented as a centralized platform for tuition centre operations. It comprises an administrator web application, student and tutor mobile applications, and an Express.js backend integrated with Supabase Authentication and PostgreSQL. The implemented functions include user management, timetable scheduling, attendance verification, attendance reporting and notifications. The following subsections describe the principal implementation outcomes.

Administrator Web Application

The administrator web application serves as the primary management interface for tuition centre operations. After authentication, the dashboard presents the numbers of registered students, tutors, subjects and classes, together with attendance summaries and scheduled sessions. Administrators can manage user accounts, centres, classrooms, subjects, enrolments and timetables from a centralized interface. Figure 3 shows the administrator dashboard.

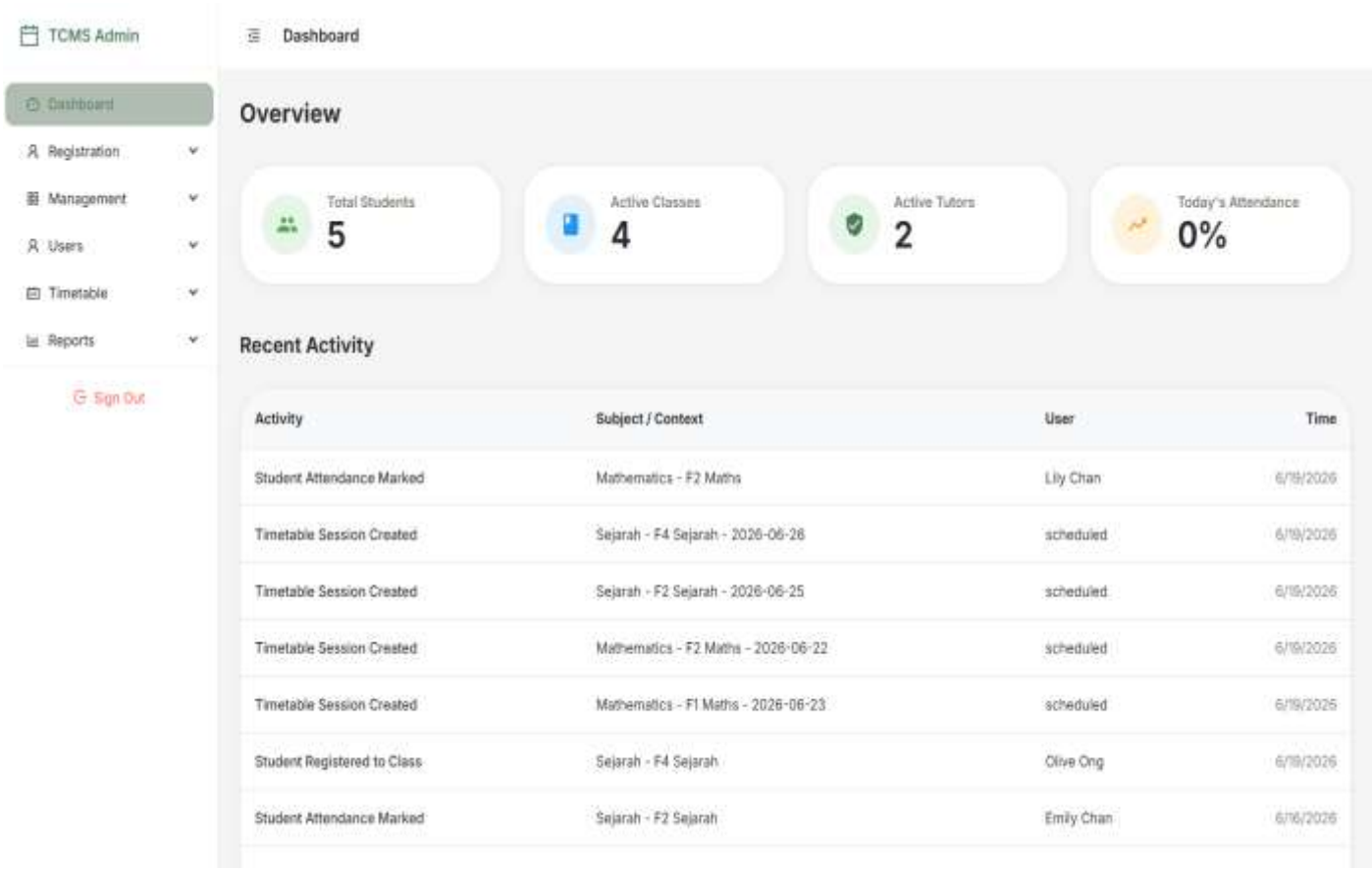


Figure 3: Administrator Web Dashboard Interface

Timetable Management

The timetable management module enables administrators to create and maintain class schedules through a drag-and-drop interface. Before a timetable is saved, the system checks classroom availability and tutor schedules for conflicts. Once a timetable is finalized, the system generates weekly class sessions automatically. Students and tutors can then access their role-specific timetables through the mobile application. Figure 4 illustrates the timetable scheduling interface and generated weekly sessions.

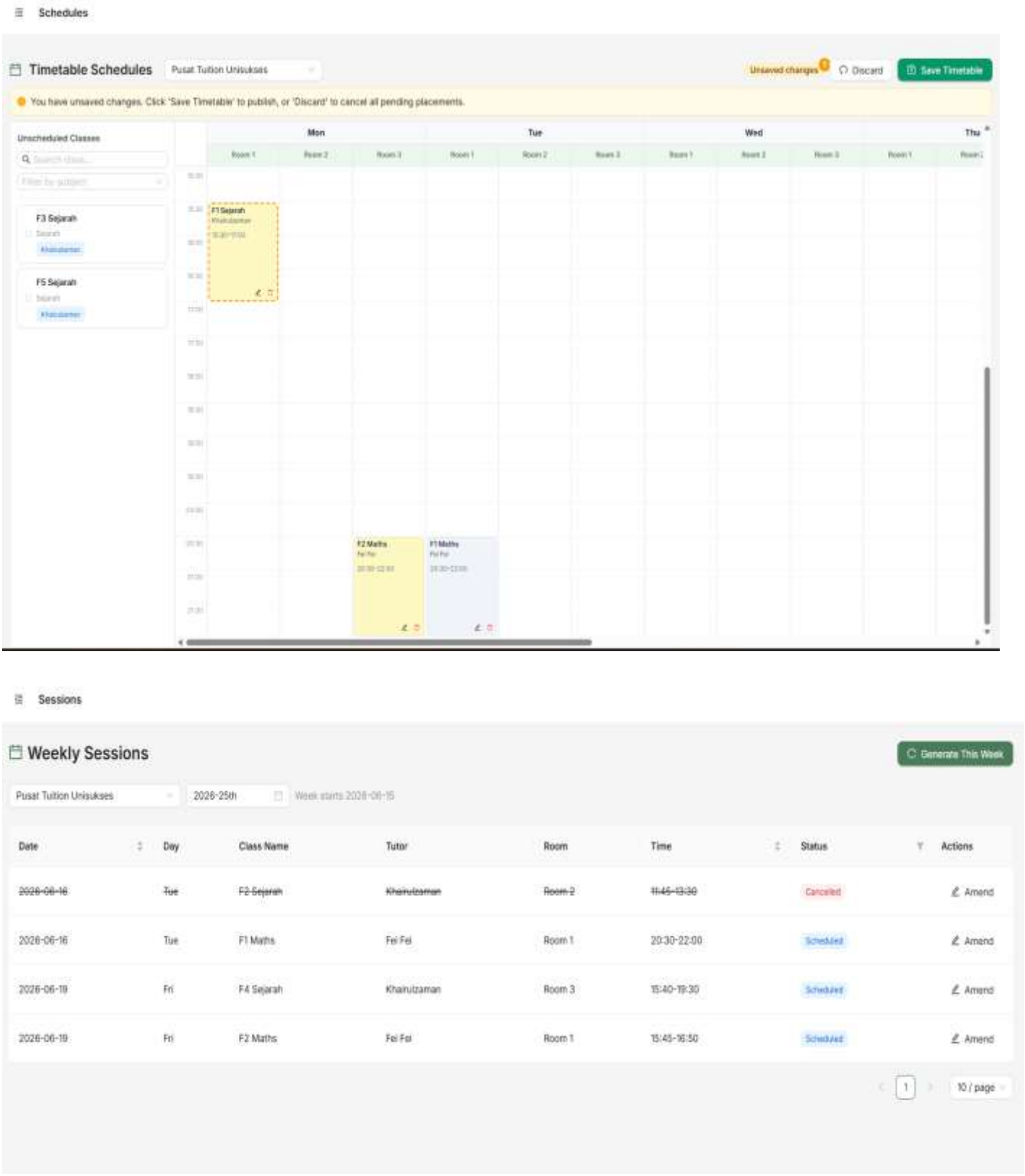


Figure 4: Timetable Scheduling and Weekly Session Interfaces

Location-Based Attendance Verification

The prototype incorporates location-based attendance verification. A student can submit attendance only when the reported GPS location falls within the predefined geofence around the tuition centre. When a submission is made, the backend compares the reported location with the stored boundary before saving the record. This

mechanism is intended to reduce invalid attendance submissions; its accuracy has not yet been evaluated under operational conditions. Figure 5 shows the student attendance verification interface.

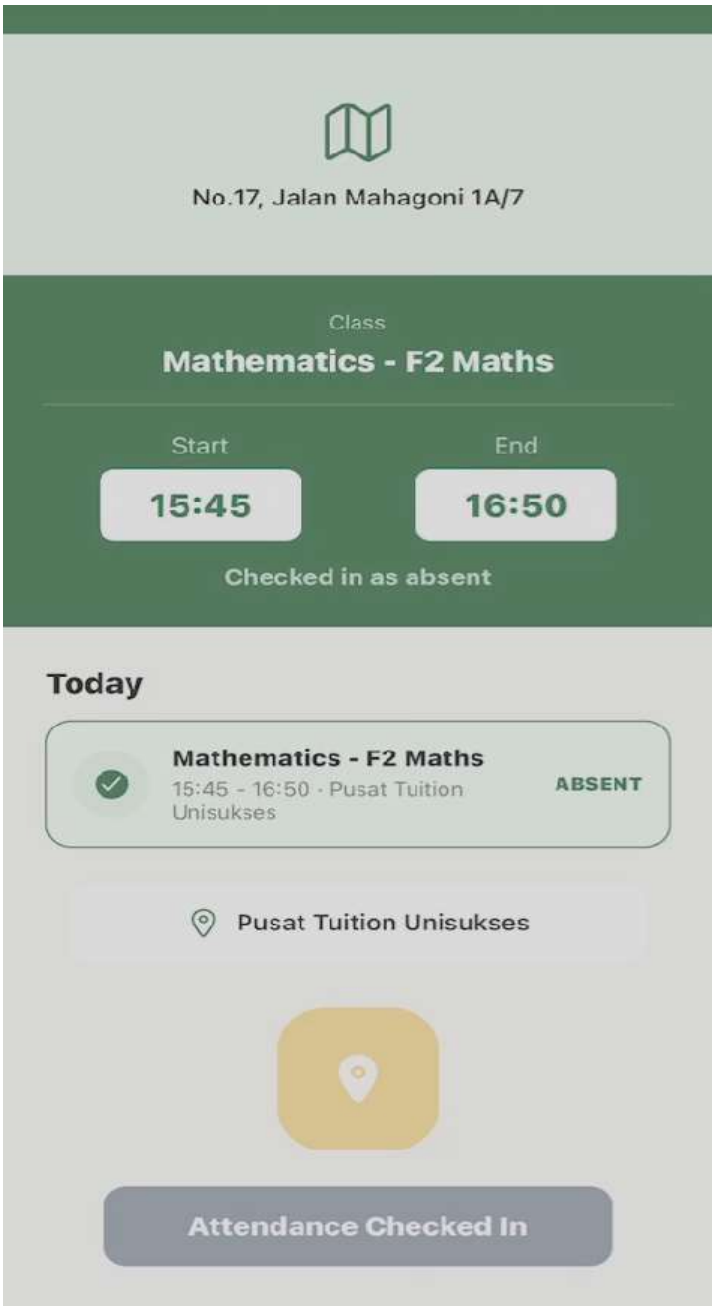
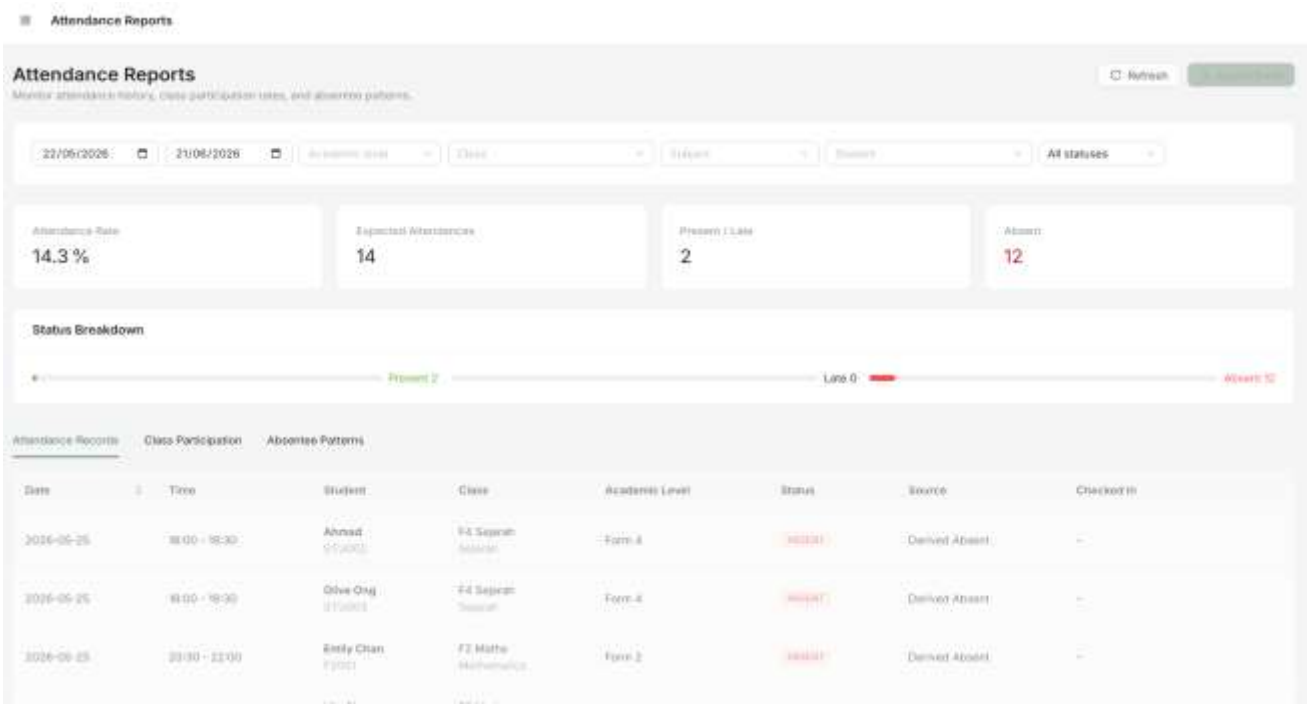


Figure 5: Student Attendance Verification

Attendance Monitoring and Notification

Tutors can view attendance records for their assigned classes through the mobile application, while administrators can generate attendance reports through the web application. Attendance records are stored in the centralized database for subsequent monitoring and reporting.

The prototype also integrates an Expo push notification service. Notifications can be issued for upcoming classes, timetable updates and attendance status changes, allowing relevant information to be delivered directly through the mobile application. Figure 6 presents the attendance reporting and mobile notification interfaces.



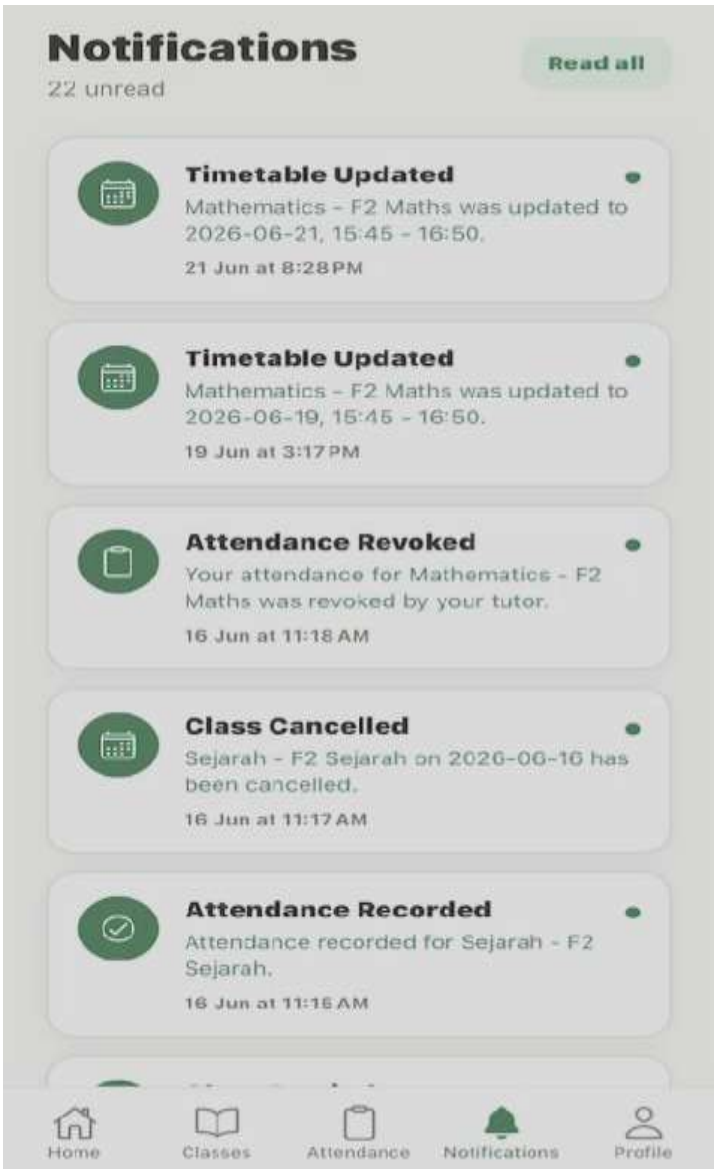


Figure 6: Attendance Reporting and Mobile Notification Interfaces

DISCUSSION

The prototype demonstrates how timetable management, attendance recording and notifications can be integrated within a role-based web and mobile architecture. In relation to the project objectives, the implementation provides a centralized timetable workflow and a geofencing rule for location-aware attendance submission. This extends the tuition management functions described by Hanafiah and Ab. Aziz (2022) by combining scheduling with mobile location verification, while the geofencing design is consistent with approaches reported by Che Fauzi et al. (2025), Eweoya et al. (2025) and Uddin et al. (2014).

The main contribution is therefore the system design and its implementation as a functional prototype for a tuition centre context. The centralized architecture enables the same timetable and attendance data to be presented through interfaces tailored to administrators, tutors and students. The practitioner-informed requirements also helped align the implemented functions with workflows observed by the developer while working as a part-time tutor.

The study has several limitations. Requirements were informed primarily by one developer's practitioner experience and the prototype has not undergone formal functional, integration, usability, performance or security testing. It has also not been piloted in an operating tuition centre. GPS measurements may be affected by device capability, connectivity and indoor conditions, so the geofence boundary should not be assumed to verify presence perfectly.

Future evaluation should involve tuition centre administrators, tutors and students in structured functional and usability testing. The evaluation should measure task-completion success, perceived usability, system response time, attendance verification accuracy, geofence false-positive and false-negative rates, notification delivery reliability and scheduling conflict detection accuracy. A pilot deployment involving more than one tuition centre could subsequently examine the system's operational suitability across different settings.

CONCLUSION

This study designed and implemented a functional prototype that centralizes timetable management, attendance recording, reporting and notifications for tuition centre operations. The prototype combines an administrator web application, student and tutor mobile applications, an Express.js backend, Supabase services and a geofencing rule for location-aware attendance submission. The project shows that these components can be integrated within a single role-based architecture. Because the system has not yet undergone formal testing or operational deployment, no conclusion can be drawn about its usability, accuracy or effect on administrative workload. The prototype therefore provides a foundation for structured evaluation with tuition centre stakeholders, including functional, usability, performance, security and location-accuracy testing before operational deployment.

ACKNOWLEDGEMENT

The authors acknowledge the use of an artificial intelligence-based language assistance tool during the preparation of this manuscript. The tool was used to support grammar correction, improve sentence clarity and enhance the overall readability of the manuscript. The authors remain fully responsible for the content, analysis, interpretations and conclusions presented in this paper.

Ethical Approval

Ethical approval was not applicable because this study focused on the design and implementation of a software prototype and did not involve human or animal participants or the collection of research data from individuals.

Conflict Of Interest

The authors declare no conflict of interest.

Data Availability

No research dataset was generated or analysed in this study. Information supporting the system design and implementation is presented in this article.

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