Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

ClassroomPlus:

A Gamified Web-Based Extension for Google Classroom with AI-Driven Revision and Productivity Analytics

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Abstract - Google Classroom has emerged as one of the most widely deployed learning management systems across educational institutions worldwide, yet it continues to lack several features that are considered fundamental to sustaining long-term student engagement—most notably gamification, integrated study tools, and intelligent content-based assessment. This paper presents ClassroomPlus, a full-stack web application engineered as a functional extension of the Google Classroom ecosystem. The platform leverages the Google Classroom, Drive, and Forms APIs through OAuth 2.0-authenticated sessions to pull real-time course data, after which it layers a comprehensive gamification framework comprising experience points, leveling, achievement badges, streak tracking, and competitive leaderboards. In addition, ClassroomPlus integrates the Gemini generative AI model to automatically construct multiple-choice quizzes from course materials stored on Google Drive, enabling curriculum-aligned self-assessment without instructor intervention. A Pomodoro-inspired focus timer, a task scheduling engine with time-slot rewards, peer-to-peer messaging through the Classroom roster API, and a discussion forum round out the feature set. The application front end is built using React with TypeScript while the server side employs Spring Boot backed by MongoDB, and the entire system is containerized via Docker for deployment on cloud platforms. Preliminary qualitative observations from internal testing suggest that the incorporation of game mechanics alongside AI-generated revision content noticeably improves student interaction with otherwise static course material.

Keywords: Google Classroom Extension, Gamification, Learning Management System, Generative AI, Quiz Generation, Pomodoro Technique, Spring Boot, React, MongoDB, Student Engagement

1. INTRODUCTION

The global shift toward digital learning environments, accelerated by events of recent years, has positioned platforms such as Google Classroom at the center of everyday academic workflows. Google Classroom provides an accessible and well-integrated environment for distributing coursework, posting announcements, and collecting submissions. Nevertheless, instructors and students alike have observed that the platform operates primarily as a content distribution tool; it does not, on its own, cultivate the kind of behavioural engagement that keeps learners returning to the material outside mandatory deadlines [1].

Gamification—broadly understood as the purposeful application of game design elements within non-game settings—has attracted considerable attention in education research precisely because it addresses this engagement gap [2]. When learners encounter point systems, badges, leaderboards, and streaks, they often demonstrate higher participation rates and greater willingness to revisit content voluntarily [3]. The psychological basis for this effect is well established in self-determination theory, which holds that human motivation thrives when the needs for competence, autonomy, and relatedness are satisfied [4]. Gamified learning platforms can, when designed thoughtfully, fulfill all three needs by allowing students to gauge their own progress, choose how and when they engage, and compare their standing with peers.

At the same time, the rapid maturation of large language models has opened the door to automated quiz generation—a capability that can substantially reduce the burden on instructors while simultaneously providing students with on-demand formative assessments. Retrieval-augmented generation approaches, in which the AI model is grounded in specific course documents, help ensure that the generated questions remain relevant to the curriculum rather than drifting into territory the student has not yet studied [5].

ClassroomPlus was conceived to address these converging trends. Rather than operating as a standalone platform that competes with Google Classroom, the application was deliberately designed as an extension layer that authenticates against the same Google account, reads from the same course roster, and accesses the same Drive files. The innovation, therefore, lies not in replacing an existing tool but in augmenting it with capabilities that Google has not yet chosen to implement natively. This paper describes the architecture, design philosophy, feature set, implementation specifics, and preliminary observations from development-phase testing of the system.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

2. LITERATURE REVIEW

2.1 Gamification in Educational Contexts

Deterding et al. [2] introduced one of the earliest and most frequently cited definitions of gamification, describing it as the incorporation of game design elements—such as points, badges, leaderboards, and progress indicators—in non-game environments. Since that foundational work, a substantial body of research has investigated whether and how these elements influence learner behaviour across various educational levels.

Systematic reviews conducted between 2023 and 2025 consistently observe that gamification yields positive effects on motivation and engagement, though the strength of these effects varies depending on how closely the game mechanics are aligned with specific learning objectives [6]. One recurring finding across recent meta-analyses is that gamification works most effectively when it supports the learner's sense of autonomy and competence, rather than simply layering extrinsic rewards onto an unchanged pedagogical structure [4]. In other words, a badly designed point system can feel coercive, whereas one that mirrors genuine mastery can genuinely motivate.

A noteworthy experimental study conducted within Google Classroom itself tested a gamified model involving team achievements, multi-component assessments, and public ratings. The results confirmed increased student engagement and enhanced digital competence among participants, lending direct empirical support to the idea that Google Classroom can serve as a viable host environment for game-based interventions [7].

Despite these encouraging findings, several barriers to wider adoption persist. Teachers frequently report insufficient training and a lack of time to configure gamification frameworks manually. The technical complexity of integrating third-party game mechanics with an existing LMS also remains a significant challenge, particularly when the LMS in question does not expose a comprehensive API surface for customization [6].

2.2 Productivity Techniques and Study Timers

The Pomodoro Technique, originally formalised by Francesco Cirillo in the late 1980s, prescribes focused work intervals (traditionally twenty-five minutes) separated by short breaks. Recent experimental research has investigated whether this structured approach outperforms self-regulated break-taking among university students. A 2023 study published in the British Journal of Educational Psychology found that while the Pomodoro Technique did not consistently outperform self-regulated strategies in measurable productivity, participants did report that the structured intervals helped reduce the psychological barrier to beginning a study session [8]. This observation aligns with practical student experience: the hardest part of studying is often starting, and a defined interval makes the commitment feel manageable.

ClassroomPlus builds on this insight by integrating a configurable Pomodoro-style focus timer directly within the dashboard, binding it to specific tasks so that completion of a timed session automatically marks the associated assignment as done and awards experience points proportional to the duration.

2.3 AI-Powered Assessment Generation

Automated question generation using large language models has moved from proof-of-concept demonstrations to production-grade integrations within the span of just a few years. Recent work has shown that LLMs can produce pedagogically sound multiple-choice questions when they are fed the specific textual content from which the assessment should be drawn, rather than relying on the model's general pre-training knowledge [5]. This retrieval-augmented approach is critical in educational settings, where the accuracy and relevance of every question directly impact student trust in the assessment.

A 2025 full-stack implementation for the Canvas LMS demonstrated end-to-end AI quiz generation with LTI-compliant grade pass-back, confirming that such integrations are technically feasible and well received by early-adopter instructors [9]. However, most published implementations to date target institution-grade LMS platforms with extensive plugin architectures. Very few have attempted to bring similar capabilities to Google Classroom, which has a comparatively limited extension ecosystem.

2.4 Google Classroom API and Extension Ecosystem

Google Classroom exposes a RESTful API that permits external applications to read courses, coursework, announcements, and rosters after the user grants OAuth 2.0 consent. The API also surfaces Google Drive file metadata associated with announcements and assignments, enabling downstream applications to retrieve and process the actual course materials [10].

Despite this API surface, the Google Classroom ecosystem has not seen the proliferation of third-party extensions that characterise more mature LMS platforms. ClassroomPlus exploits the available API endpoints to the fullest permitted extent, constructing an enriched student dashboard that is continuously synchronised with the institution's live Classroom data. The major innovation of this work, therefore, is not the individual features in isolation but the cohesive integration of gamification, AI assessment, productivity tools, and social communication into a single extension layer built atop an already-familiar learning environment.

3. SYSTEM ARCHITECTURE

3.1 High-Level Overview

ClassroomPlus follows a three-tier architecture comprising a React-based single-page application on the client side, a Spring Boot RESTful API server on the middle tier, and a MongoDB document store as the persistence layer. Google's OAuth 2.0 infrastructure and API services act as an external dependency that the back end communicates with on behalf of each authenticated user.

The flow of data through the system can be summarised as follows. A student arrives at the platform and initiates a Google sign-in. The back end conducts the full OAuth 2.0 authorization-code exchange, obtaining an access token, a refresh token, and an ID token. The credential is stored in the user's HTTP session, and the ID token is verified to extract the student's email address. From that point onward, the back end can call the Classroom, Drive, and Forms APIs using the stored credential, and the front end communicates

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exclusively with the Spring Boot server through same-origin REST calls.

3.2 Front-End Architecture

The client application is authored in TypeScript using the React library, with Vite serving as both the development server and production bundler. State management is handled through React Context providers—an AppContext for global application state (current user, theme, tasks, leaderboard data) and an AuthContext for session lifecycle management. The interface incorporates the Framer Motion animation library for smooth page transitions and loading overlays, the Lucide icon library for consistent iconography, and the Sonner library for non-intrusive toast notifications.

Styling is controlled through a CSS custom-property design system, which exposes HSL-based colour tokens for the primary, secondary, background, card, foreground, and border roles. Multiple colour palettes—including dark, light, red, lavender, and cyan variants—are available to the user, and the selected theme dynamically rebinds every custom property. This approach guarantees that all visual elements respect the active theme without embedding colour decisions in individual component files.

3.3 Back-End Architecture

The server application is written in Java 17 using the Spring Boot 3.3 framework. Maven handles dependency management and build orchestration. The major service classes include AuthController for managing the Google OAuth 2.0 login, callback, and token-exchange endpoints; GoogleApiService which wraps the Google Classroom and Drive Java client libraries for fetching courses, assignments, announcements, roster entries, and raw file content; AiService which handles document text extraction and communicates with the Gemini API for quiz generation; AiController which exposes REST endpoints for quiz generation; CommunicationController for peer-to-peer chat messages and threaded forum topics; and DashboardController which provides proxied access to courses, assignments, and announcements for the front-end dashboard.

3.4 Database Layer

MongoDB was selected for its schema-flexible document model, which accommodates the heterogeneous and frequently evolving per-user data structures (streaks, penalty histories, task arrays, badge collections) without requiring migration scripts on every schema change. Each registered user is stored as a single document containing both authentication metadata and all gamification-related fields. Chat messages and forum topics occupy dedicated collections with appropriate indexing.

3.5 Deployment

The entire application is containerised using a Dockerfile that performs a multi-stage build: the front-end assets are compiled by Vite, copied into the Spring Boot static resource directory, and the resulting JAR is executed within a minimal Java runtime image. This approach produces a single deployable artefact that serves both the API and the client application from the same origin, eliminating cross-origin complications and simplifying session management.

4. FEATURE DESCRIPTION

4.1 Google Classroom Integration

Upon authentication, ClassroomPlus calls the Classroom API to retrieve the student's enrolled courses, the coursework items within each course (including attached Drive file metadata), and the announcement stream. These data are rendered on the dashboard as a scrolling news banner that highlights activity from the past five days and as synchronisable task entries that can be imported into the personal task manager with a single button press.

The integration goes beyond passive data retrieval. The application also queries the Classroom roster API to obtain the list of students enrolled in each course. These classmates are presented in a peer-messaging interface that allows direct communication through MongoDB-backed chat and a threaded discussion forum, both accessible from within the platform without leaving the Classroom context.

4.2 Gamification Framework

The gamification layer in ClassroomPlus is structured around five interlocking mechanisms:

- Experience Points (XP) and Leveling: Students earn XP through completing focus-timer sessions linked to tasks (with XP proportional to session duration), finishing scheduled tasks on time, claiming daily login rewards, and answering AI-generated quiz questions correctly. The level is computed as a function of cumulative XP, and a visual progress bar on the scoreboard shows advancement toward the next threshold.
- Streak Calendar: Inspired by contribution-graph visualisations, the streak calendar renders an entire year as a grid of daily cells. Each cell is colour-coded to indicate whether the student logged in, completed a study session, or remained inactive. Current streak and longest streak metrics are prominently displayed, encouraging habitual daily participation.
- Badges and Achievements: A predefined catalogue of badges rewards milestones such as total study hours, consecutive login days, Pomodoro session counts, and quiz scores. Once earned, badges appear on the student's profile and contribute to their leaderboard ranking.
- Leaderboard: A global scoreboard ranks all users by XP, level, badge count, or task completion. The interface toggles between real registered users and demonstration users to maintain competitive context.
- Penalty System: To discourage task abandonment and deadline violations, ClassroomPlus deducts XP when a student deletes an uncompleted scheduled task or fails to complete a task by its scheduled date. Penalty records are logged in a dedicated history panel, maintaining transparency.

4.3 AI-Powered Revision and Quiz Generation

The revision module allows students to select course materials—either from their local file system or from Google Drive files attached to their Classroom courses—and request the generation of a multiple-choice quiz at a specified difficulty level (easy, medium, or hard) with a configurable question count between five and fifteen.

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When the student initiates generation, the following pipeline executes: (1) Drive files are downloaded using the stored OAuth credential, with Google Workspace formats exported to PDF before download; (2) the AiService extracts raw text from each document using format-appropriate libraries—PDFBox for PDFs, POI for DOCX files, and standard character-set decoding for plain text; (3) the combined text is dynamically divided into one to four chunks based on total length to stay within API token limits; (4) each chunk is submitted to the Gemini API as an independent quiz-generation request using Java's CompletableFuture for concurrent processing; and (5) the resulting JSON arrays from each chunk are concatenated into a single quiz streamed back to the front end.

In addition to quizzes, a quick-revision mode sends selected text to the Gemini API with a simplification prompt, returning an age-appropriate summary that helps students grasp dense material more rapidly.

4.4 Focus Timer with Pomodoro Integration

The integrated focus timer supports both preset and custom durations up to one hundred and twenty minutes. When a student starts a task from the task manager, the timer automatically initialises with the task's assigned duration, and a visual link between the timer and the active task makes it clear which objective is being worked on. Upon successful completion of a focus session lasting at least twenty minutes, the system awards XP equivalent to the session duration in minutes, marks the task as complete, and initiates an automatic break whose length is proportional to the focus period. Sessions under twenty minutes or those started manually from the timer panel (without an associated task) do not earn XP—a deliberate design choice to prevent trivial exploitation of the reward system.

4.5 Task Scheduler with Time-Slot Bonuses

Beyond the general task manager, ClassroomPlus offers a dedicated task scheduler that allows students to commit to specific future dates and, optionally, specific time slots. Completing a scheduled task on its intended day earns fifteen base XP. If the student opted for a time-slot bonus and completes the task within a forty-minute window after the scheduled time, an additional one hundred XP is awarded. Missing the scheduled date incurs a five-XP penalty. Abandoning an incomplete scheduled task incurs a larger penalty. This mechanism draws on commitment-device research, which suggests that choosing a specific time to perform a task increases the probability that the task will actually be carried out [11].

4.6 Peer Communication

The messaging module retrieves Google Classroom classmates through the roster API and enriches the list with internal users who share the same course registrations in MongoDB. Each peer is displayed with their profile picture (where available) and course affiliation. Clicking on a peer opens a chat interface backed by a MongoDB collection of timestamped messages. A separate forum tab supports threaded discussions organised by course, enabling broader conversations that are visible to all enrolled students.

5. IMPLEMENTATION DETAILS

5.1 Technology Stack Summary

Layer	Technology
Front End	React 18, TypeScript, Vite, Framer Motion, Lucide Icons, Sonner
Back End	Java 17, Spring Boot 3.3, Maven
Database	MongoDB (via Spring Data MongoDB)
Authentication	Google OAuth 2.0 (Authorization Code Flow)
External APIs	Google Classroom API v1, Google Drive API v3, Google Forms API v1
AI Engine	Google Gemini (via REST)
Document Parsing	Apache PDFBox 3.0, Apache POI 5.2
Deployment	Docker (multi-stage build), Render

5.2 Authentication Flow

The authentication sequence merits detailed description because it illustrates how the extension model works in practice. The front end calls GET /api/auth/login, receiving a Google authorization URL with the required scopes (Classroom read, Drive read/write, Forms, OpenID, email, profile). The browser redirects to Google, where the student authenticates and consents. Google redirects back to GET /api/auth/callback with an authorization code. The back end exchanges the code for tokens, verifies the ID token to obtain the student's email, upserts a user record in MongoDB, generates a one-time exchange token, and redirects the browser to the front end's /auth route with the token and email as query parameters. The front end calls GET /api/auth/exchange, which binds the Google credential to the server-side HTTP session, completing the handshake.

Subsequent API calls to Google services are performed server-side using the session-stored credential, ensuring that access tokens and refresh tokens never reach the browser.

5.3 Gemini API Integration

The AI service communicates with the Gemini API over HTTPS using Spring's RestTemplate. Each request packages the extracted document text along with a carefully crafted system prompt that specifies the desired output format (raw JSON array with no markdown fencing), the question count, and the difficulty level. The service implements exponential back-off retry logic for both HTTP 429 (rate-limit) and HTTP 503 (service-unavailable) responses, reducing the input context by fifty percent on second-attempt 503 errors to accommodate potential token-window constraints.

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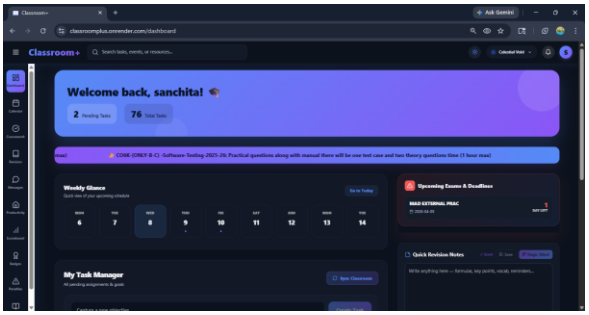
5.4 Streak and Daily Login Logic

The streak system operates on a calendar-day basis. Upon each login, the current date is compared against the user's stored lastLoginDate. If the gap is exactly one day, the currentStreak counter increments; if the gap exceeds one day, the counter resets to one; and if the student logs in on the same day again, no change occurs. The longestStreak field is updated whenever currentStreak surpasses the previous record. Each login also triggers a ten-XP daily reward, and a streakCalendar array of date-status objects is maintained for rendering the year-long activity heatmap.

6. SYSTEM IMPLEMENTATION & RESULTS



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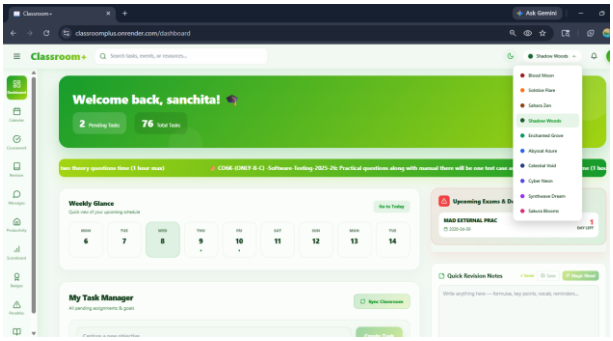

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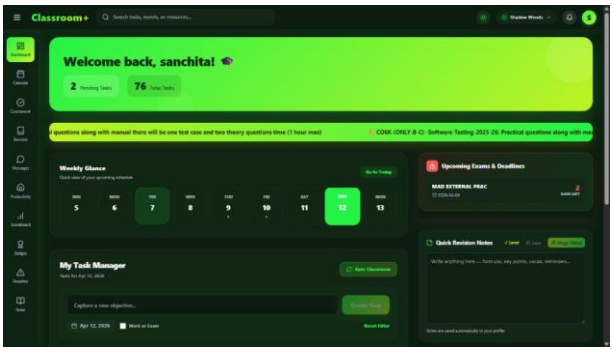

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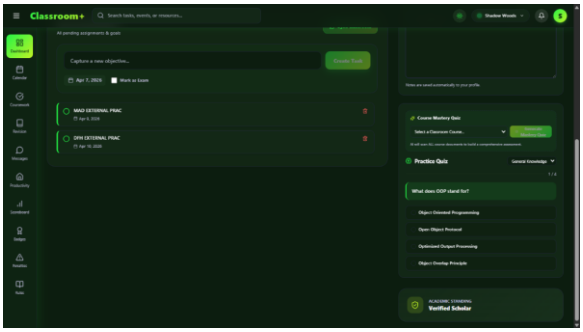


Fig1(d)

Fig. 1: Integrated Dashboard with Activity Ticker and Verified User Stats

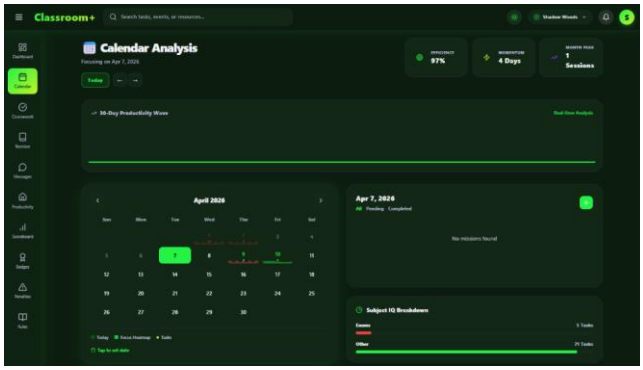
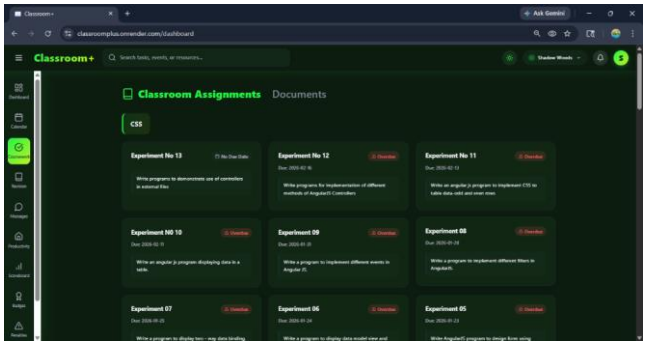


Fig. 2: Productivity Analytics and Subject IQ Visualization



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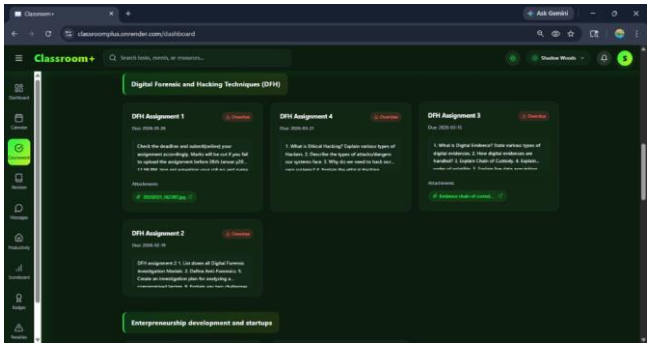

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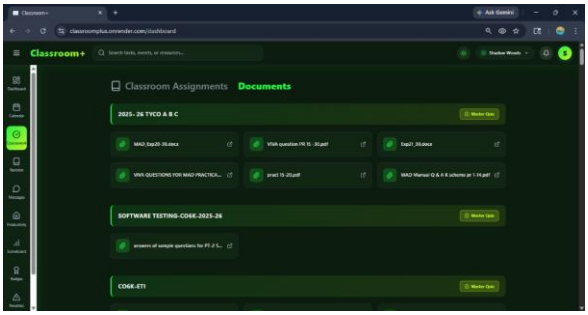
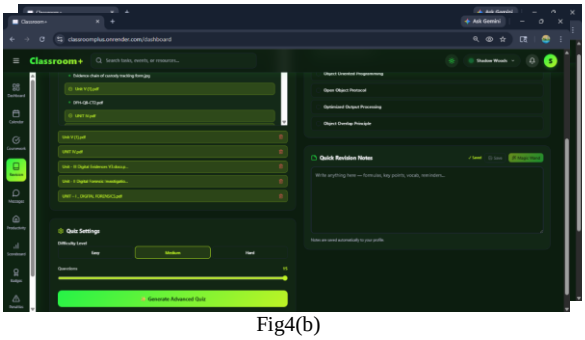


Fig3(c)

Fig. 3: Coursework Dashboard: Assignment Status and Master Quiz Entry

Fig4(a)



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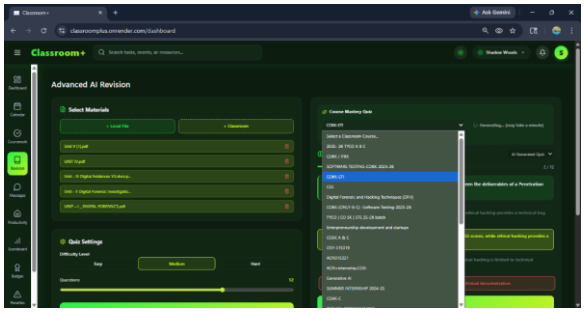

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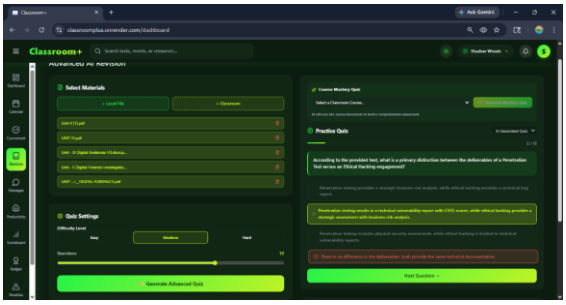
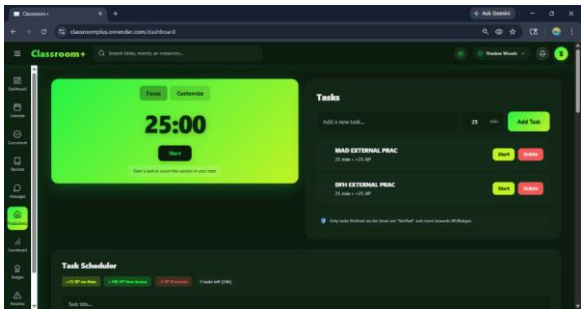


Fig4(d)

Fig. 4: Advanced AI Revision Engine: Materials, Settings, Loading, and Feedback (All Screens)



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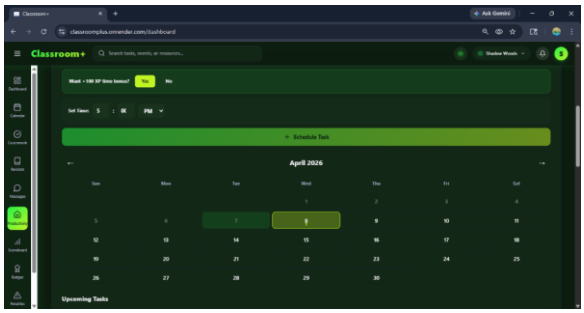

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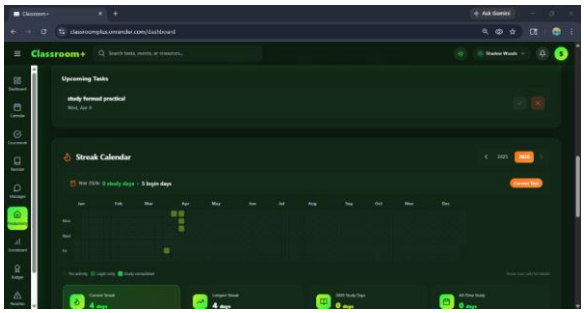

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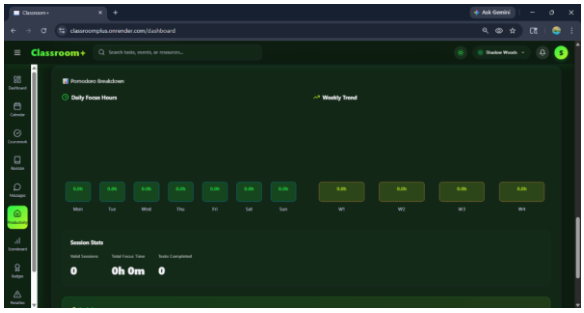

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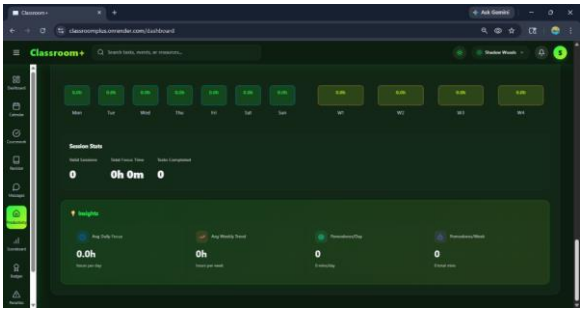

Fig5(e)

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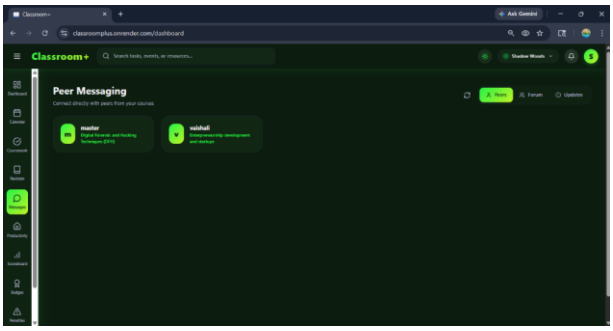
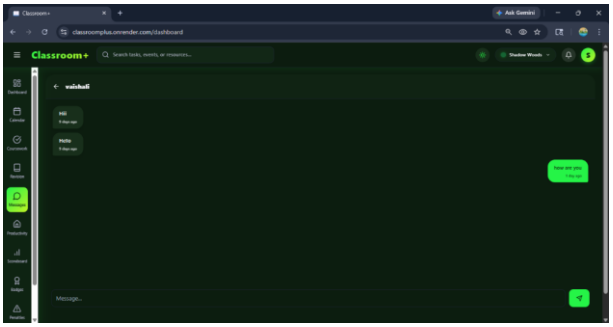
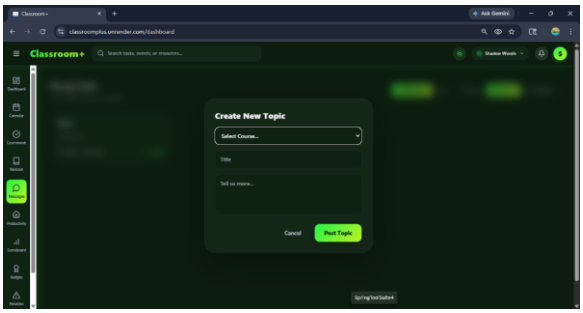
Fig. 5: Productivity Suite: Verified Pomodoro Timer, Task Scheduler, and Heatmaps







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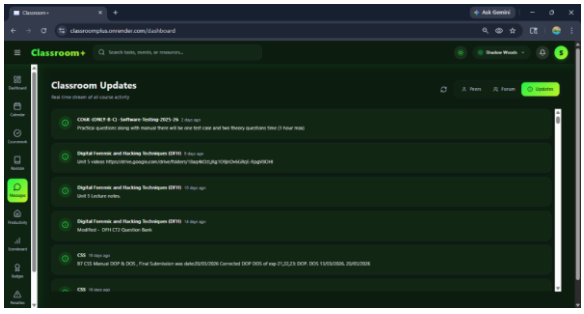
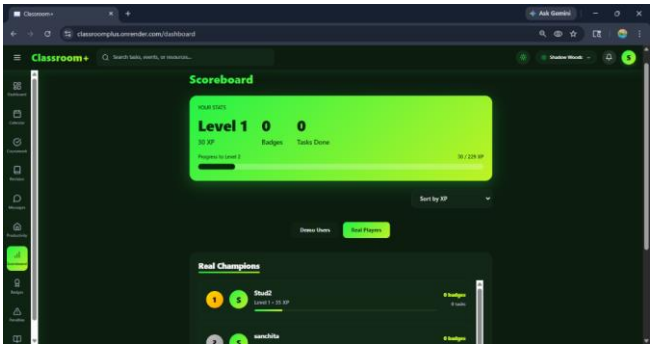


Fig6(d)

Fig. 6: Social Hub: Messaging, Course-Based Forums, and Activity Streams



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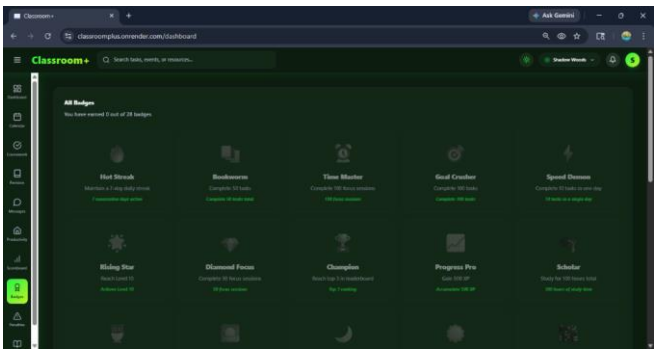

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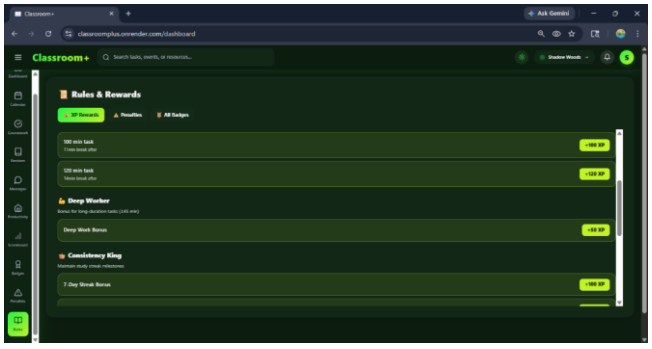

Fig7(c)

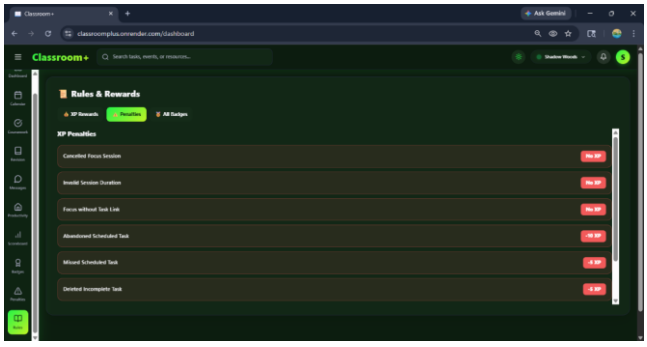

Fig7(d)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

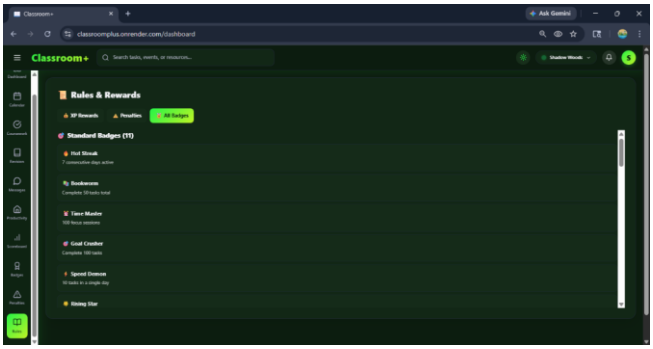

Fig7(e)

Fig. 7: Gamification Economics: Scoreboard, 28-Badge Achievement Grid, and Penalty History

7. RESULTS AND DISCUSSION

7.1 Qualitative Observations

Because ClassroomPlus is currently in the development and internal testing phase, large-scale quantitative evaluation has not yet been conducted. However, several noteworthy observations emerged during iterative testing with a small cohort of student testers.

- Voluntary Engagement: Testers reported visiting the platform between scheduled class sessions to check their streak status and XP, behaviour that is not typically observed with plain Google Classroom usage.
- Quiz Relevance: The AI-generated quizzes were judged to be acceptably aligned with the source material, though occasional drift in difficulty was noted when documents contained highly specialised terminology.
- Timer Completion Rates: When the focus timer was linked to a specific task with XP incentives, testers completed their sessions at a noticeably higher rate compared to anonymous, untimed study periods.
- Peer Communication: The messaging feature saw limited use during testing, suggesting that communication features may require a critical mass of concurrent users before they become self-sustaining.

7.2 Comparison with Existing Solutions

Several commercial platforms offer gamified learning experiences—Duolingo, Khan Academy, and Kahoot among the most prominent. However, these platforms are purpose-built ecosystems that require content to be authored within their own environments. None of them integrate with Google Classroom's live course data, meaning that a student using any of those platforms would still need to maintain a separate workflow for their institutional coursework. ClassroomPlus occupies a different niche: it does not require content re-creation; instead, it activates content that already exists in the student's Classroom account.

Other Google Classroom add-ons available through the Google Workspace Marketplace tend to focus on narrow functionalities such as attendance tracking or plagiarism checking. To the best of the authors' knowledge, no existing add-on combines gamification, AI quiz generation, Pomodoro study sessions, and social communication within a single integrated interface that reads directly from the Classroom API.

7.3 Limitations

Several limitations should be acknowledged. First, the Gemini API imposes rate limits on the free tier, which restricts the number of quiz-generation requests a student can make per day. Second, the current implementation relies on server-side HTTP sessions rather than stateless JWT tokens, which limits horizontal scalability. Third, the penalty system, while transparent, may feel discouraging to students who are already struggling, and further research is needed to calibrate the balance between extrinsic punishment and supportive feedback. Finally, rigorous controlled-group experiments with pre- and post-test measurements are necessary to substantiate the engagement benefits that were observed anecdotally during development.

8. FUTURE SCOPE

Several directions for future development are under active consideration:

- Controlled Experimental Studies: A formal experiment with a treatment group using ClassroomPlus alongside Google Classroom and a control group using Google Classroom alone would provide the statistical evidence needed to quantify the gamification effect size in this context.
- Adaptive Difficulty: Incorporating a student-performance feedback loop into the quiz-generation prompt could enable the AI to adjust question difficulty in real time based on the learner's accuracy history.
- Instructor Dashboard: Providing teachers with aggregate analytics on student engagement, quiz performance, and streak compliance would extend the platform's value to the pedagogical side of the classroom relationship.
- Mobile-Responsive Optimization: While the current interface is functional on mobile browsers, a dedicated responsive layout or a Progressive Web App wrapper would improve the experience for students who access coursework primarily from smartphones.
- LTI Compliance: Implementing Learning Tools Interoperability support would allow ClassroomPlus to be embedded directly within institutional LMS portals, broadening its applicability beyond the Google ecosystem.

9. CONCLUSION

ClassroomPlus demonstrates that a meaningful enhancement layer can be built on top of Google Classroom without requiring students or instructors to abandon a platform they already use daily. By integrating gamification mechanics grounded in self-determination theory, AI-driven quiz generation powered by Gemini, a structured focus timer inspired by the Pomodoro Technique, and a peer communication system derived from the Classroom roster API, the application transforms a passive content-distribution tool into an engaging, productivity-oriented learning companion.

The architecture—React on the front end, Spring Boot on the back end, MongoDB for persistence, and Google's OAuth and API

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 04 , April - 2026

infrastructure for data access—ensures that the system can be deployed as a single containerised artefact and scaled to institutional needs. Preliminary qualitative indicators are encouraging, and formal quantitative validation constitutes the next critical milestone for this research.

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