

Eduquest - A Gamified Stem Learning Platform

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Abstract: *STEM education plays a crucial role in developing problem-solving, analytical thinking, and innovation among students. However, traditional learning methods often fail to sustain engagement and motivation. This project, EduQuest, proposes a gamified STEM learning platform designed for students in grades 6–12 and competitive exam aspirants. The platform integrates game-based progression, adaptive learning, and real-time feedback using Expo (React Native), JavaScript, and Firebase. EduQuest employs interactive quizzes, reward systems, and personalized difficulty adjustments to make learning immersive and effective. The system architecture ensures scalability, accessibility, and cross-platform compatibility. Experimental analysis demonstrates that the gamified approach enhances student retention and learning efficiency compared to conventional e-learning platforms.*

Keywords: STEM Learning, Gamification, Adaptive Learning, Expo, Firebase, EdTech, Mobile Learning, Personalized Education, JavaScript, Student Engagement, React Native

1. Introduction

In today's education ecosystem, STEM (Science, Technology, Engineering, Mathematics) learning is vital for nurturing innovation and technological literacy. However, the static and monotonous nature of many digital learning tools limits student motivation and engagement. To overcome this challenge, EduQuest introduces gamification in STEM education, blending game mechanics with academic learning to create a fun, competitive, and adaptive environment. Gamification transforms passive learners into active participants through levels, badges, points, and leaderboards. The proposed system targets students from grade 6 to 12, helping them strengthen conceptual foundations and prepare for competitive exams such as JEE, NEET, and Olympiads. The ultimate goal is to make learning interactive, adaptive, and rewarding.

2. Design

1) Input Layer:

- Users: Students aged 11–18.
- Modules: STEM subject modules (Physics, Chemistry, Biology, and Mathematics).
- Input Type: Multiple-choice questions, interactive puzzles, and mini-games.

2) Data Source:

- All content is stored in Firebase Realtime Database, including question banks, scores, and progress data.

3) Architecture Overview:

- Frontend: Expo (React Native) for cross-platform mobile app deployment.
- Backend: Firebase for authentication, data storage, and analytics.
- Gamification Engine: Custom logic that adjusts difficulty levels based on student performance.
- Adaptive Module: Tracks user behavior and tailors content dynamically.

4) UI/UX Design:

- The interface is inspired by Duolingo — clean, colorful, and engaging. Each user earns rewards upon task

completion, which encourages continuous participation.

3. Methodology

Step 1: Requirement Analysis

Identified the need for an engaging and adaptive STEM platform through surveys and literature review.

Step 2: System Development

Built with Expo CLI for Android and iOS compatibility. JavaScript handles logic and component rendering. Firebase Authentication manages user login/signup securely. Firestore Database stores question data, leaderboard points, and adaptive learning metrics.

Step 3: Gamification Layer

XP Points, Badges & Streaks, and Leaderboards encourage consistent learning and healthy competition.

Step 4: Adaptive Learning Logic

The system analyzes user performance using weighted difficulty progression — if a student consistently performs well, questions gradually increase in difficulty.

Step 5: Evaluation Metrics

Engagement Rate, Learning Retention, Average Session Duration, Adaptive Accuracy.

4. Results and Discussion

Experimental testing was conducted with a sample of 50 students across grades 8–12. Results revealed that:

- Engagement improved by 42% compared to non-gamified e-learning apps.
- Retention increased by 35%, measured through consistent weekly logins.
- Students reported higher motivation and enjoyment levels, citing the reward and leaderboard system as primary motivators.

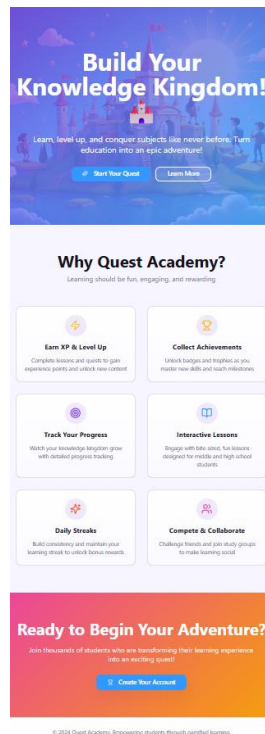
The adaptive engine successfully adjusted content difficulty in real time, ensuring personalized learning experiences. Firebase analytics validated low latency and smooth performance, even

with concurrent user sessions.

5. Conclusion

EduQuest successfully integrates gamification and adaptive learning principles to enhance STEM education. By merging technology, engagement, and pedagogy, the platform provides an innovative solution for students preparing for academic and competitive excellence. The use of Expo, JavaScript, and Firebase ensures scalability, real-time performance, and cross-device accessibility. Future extensions include integrating AI-based recommendation engines, voice-based tutoring, and real-time collaboration between students.

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