International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

BrainBox: Building a Quiz-Gated Gamified Web Platform for Active E-Learning

Sharad Tiwari[1], Saurabh Patel[2], Manvi Sharma[3]
[123] B.Tech Final Year, Dept. of Information Technology, AIMT Lucknow, India
Guide: Mr. Niranjan Srivastava, Asst. Professor, Dept. of IT, AIMT Lucknow

---

Abstract - Most students who enroll in online courses never finish them. They watch a few videos, lose interest, and the platform does nothing to stop them. BrainBox is our response to this — a web-based e-learning system built around a mandatory quiz checkpoint called the Brain Breaker Quiz, where learners must score at least 60 percent before the next module unlocks. Beyond this gate, the platform uses points, achievement badges, and a leaderboard to sustain motivation. A personal dashboard shows each learner where they stand, and an admin panel gives instructors control over course content and quiz creation. The system was developed using React.js on the frontend, Node.js with Express.js on the backend, and MongoDB for data storage. We ran a four-week study with 45 undergraduate students divided between BrainBox and a conventional video-based LMS. The BrainBox group completed around 75 percent of assigned modules against roughly 40 percent for the other group. Average session time rose from 15 minutes to about 35 minutes, and user satisfaction was rated 4.5 out of 5. This paper covers how the system was designed, what was implemented, what problems came up, what the evaluation found, and what we would improve in future work.

Keywords: *gamified e-learning, quiz-gated progression, Brain Breaker Quiz, React.js, Node.js, MongoDB, learner engagement, interactive assessment.*

I. INTRODUCTION

Signing up for an online course has never been easier — a few clicks, sometimes not even a payment, and you are enrolled. But finishing that course is a completely different story. Across major open online learning platforms, completion rates consistently sit somewhere between 5 and 15 percent. People start, watch a couple of videos when the topic feels fresh, and gradually stop opening the platform. Nobody follows up. The platform has no mechanism to push back.

BrainBox was built as a final-year B.Tech project specifically because this bothered us. The core question was: what if access to the next lesson was not free? What if you had to show — even minimally — that you understood the current material before the system let you move forward? That one change shifts the entire dynamic. The learner goes from passenger to participant.

The feature built around this idea is called the Brain Breaker Quiz. After watching a module video, the next module stays locked until the student passes a short quiz on the one just watched. Fail and you can retry — but the door stays shut until you score at least 60 percent. On top of this, a points system, unlockable badges, and a leaderboard were added to keep motivation from dropping off.

The platform is a web application built from scratch — React.js on the front end, Node.js and Express for the server, MongoDB for storage. It supports user login, video-based course modules, the quiz gate, a personal progress page, and an admin dashboard for content management. It was tested with 45 students over four weeks, comparing progress against a group using a regular video-based LMS.

II. LITERATURE REVIEW

A. Why Learners Quit Online Courses

Researchers who study drop-off in online courses generally point to three overlapping causes. First, there is no social pressure — nobody notices if you stop. Second, content is structured for passive consumption, meaning a learner can advance without retaining anything. Third, the rewards for continuing are distant and abstract while the effort is immediate. When all three conditions exist together, quitting becomes the path of least resistance.

B. What Gamification Actually Does

The term gamification was formally defined around 2011 as using game-design mechanics — scoring, levelling, competition — in non-game contexts. Early studies on gamified learning were largely optimistic. A later wave of research pushed back, noting that effects were often short-lived and poorly designed reward systems could undercut internal motivation once novelty wore off. The lesson is that what you reward matters more than the fact that you reward. BrainBox was built on this principle — points are only awarded on passing a quiz, not just for watching a video.

C. Retrieval Practice and the Quiz Approach

A well-documented finding in cognitive psychology shows that testing yourself on material — even before feeling fully ready — produces stronger long-term retention than re-reading or re-watching the same content. The mechanism is that actively retrieving information from memory strengthens recall pathways, whereas passive review does not produce the same effect. This gave strong theoretical backing for mandatory quizzes — the quiz is not just a gate, it is itself a learning activity.

D. Gaps in Existing Platforms

The problem with existing platforms is not a shortage of content. Coursera, Udemy, and similar platforms host large libraries of well-produced courses. The gap is in the structure around that content. Quizzes exist on most platforms but are optional, or placed only at the end of a full course rather than after each module. Table 1 captures this comparison.

Table - 1: Feature Comparison of E-Learning Platforms

Platform	Content	Interactive	Gamification	Prog. Gate
Coursera	Good	Weak	None	None
Udemy	Good	Weak	None	None
Khan Academy	Fair	Moderate	Partial	Limited
Duolingo	Fair	Strong	Full	Lang. only
BrainBox	Good	Strong	Full	All modules

III. SYSTEM DESIGN AND METHODOLOGY

A. Architecture Overview

BrainBox runs on a three-tier setup. A React single-page application handles everything the user sees and interacts with. A Node.js and Express server handles all business logic — quiz evaluation, score calculation, badge triggers, and access control. MongoDB Atlas stores everything persistently. The frontend and backend

communicate exclusively through REST calls, passing JSON back and forth. The architecture was kept deliberately conventional — no message queues, no microservices — because for a three-developer academic project, simpler meant fewer places for things to go wrong.

Every protected route requires a valid JWT in the request header. Tokens are generated at login and expire after 24 hours. Passwords go through bcrypt with ten salt rounds before storage. All quiz evaluation logic runs server-side, which prevents any attempt to manipulate scores through the browser.

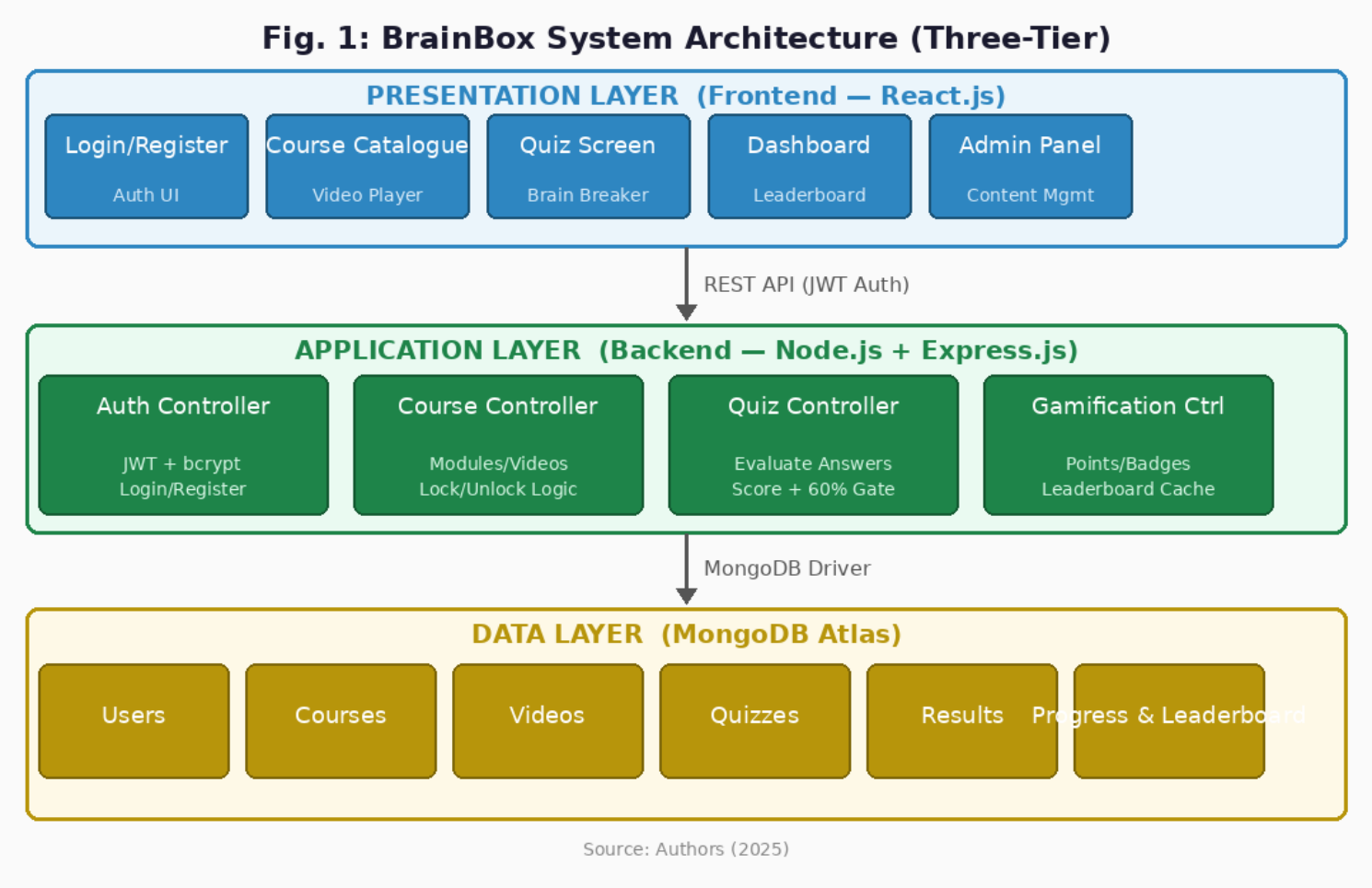

Fig. 1: BrainBox System Architecture — Three-Tier (Presentation / Application / Data Layer)

B. Brain Breaker Quiz — Core Logic

Each course is divided into modules. Each module has a video and a linked quiz. By default only the first module is unlocked at enrolment. After watching the video, the quiz button becomes active. The student answers all questions and submits. The server fetches correct answers, compares them against the submission, calculates a percentage score, and checks against the 60 percent threshold. A pass unlocks the next module and awards points. A fail returns the score and allows a retry, but the lock stays.

Concurrent submission handling was needed — if a user clicked submit twice quickly, points could be awarded twice before the first transaction completed. This was fixed by checking for an existing passing result before writing a new one: if a pass record already exists for that user-module pair, the points update is skipped.

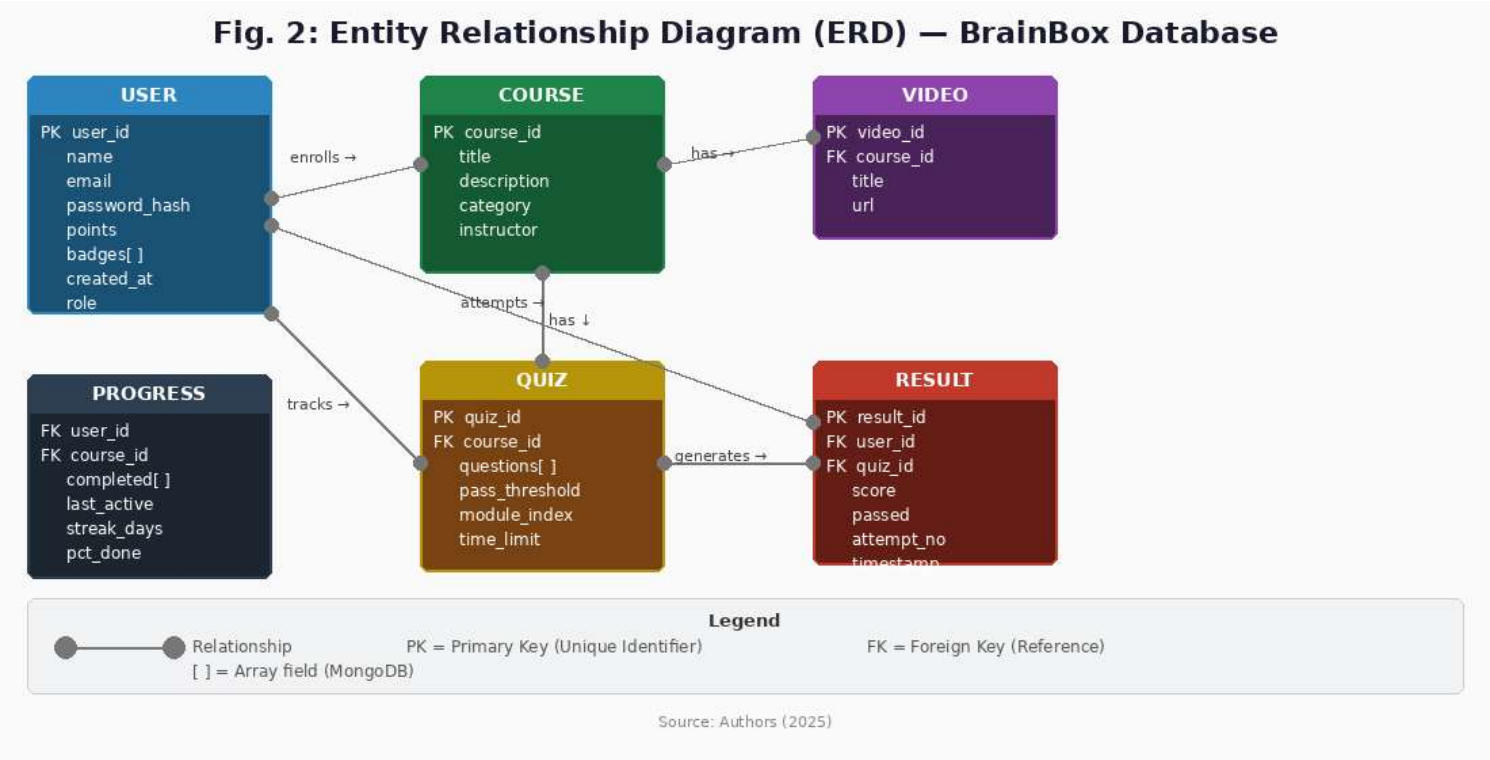

Fig. 2: Entity Relationship Diagram (ERD) — BrainBox MongoDB Collections and Relationships

C. Gamification Layer

Points accumulate across all quiz passes and feed into a leaderboard showing the top fifty users. Badges unlock at fixed milestones: first quiz pass, first full course completed, scoring above 90 percent on any quiz, and maintaining a seven-day activity streak. The leaderboard aggregation result is cached to avoid expensive queries on every page load.

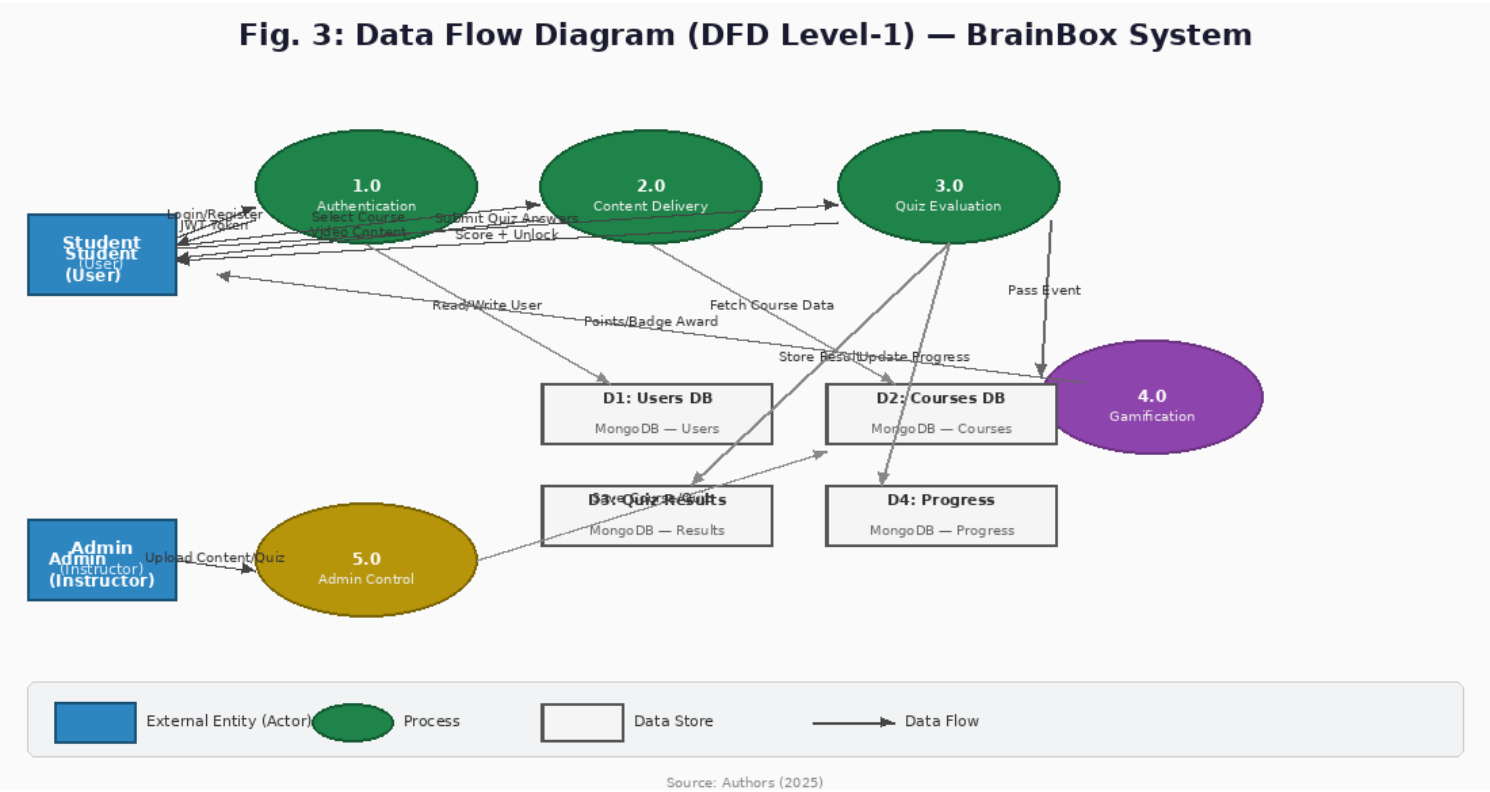

Fig. 3: Data Flow Diagram (Level-1) — BrainBox System Information Flow

D. Module Breakdown

- User Module — account creation, login/logout, JWT lifecycle, profile storage
- Learning Module — course catalogue, video playback, lock/unlock state enforcement
- Brain Breaker Quiz Module — loads questions, evaluates server-side, stores results, triggers unlock and point award
- Gamification Module — point totals, badge eligibility, leaderboard updates
- Dashboard Module — per-user view of completed modules, badges, score history

- Admin Module — add courses, upload video links, write quiz questions, review user activity

E. Technology Stack

Table - 2: Technology Stack and Component Roles

Layer	Technology	Role
Client	React.js, HTML5, CSS3	UI, quiz screen, dashboard
Server	Node.js + Express.js	APIs, quiz logic, auth
Database	MongoDB Atlas	All persistent data
Security	JWT + bcrypt	Auth, password hashing
Video	YouTube API / hosted URLs	Module lecture delivery
Hosting	Vercel + Render + Mongo Atlas	Full cloud deployment
Dev Tools	VS Code, GitHub, Postman	Build, version ctrl, test

IV. IMPLEMENTATION

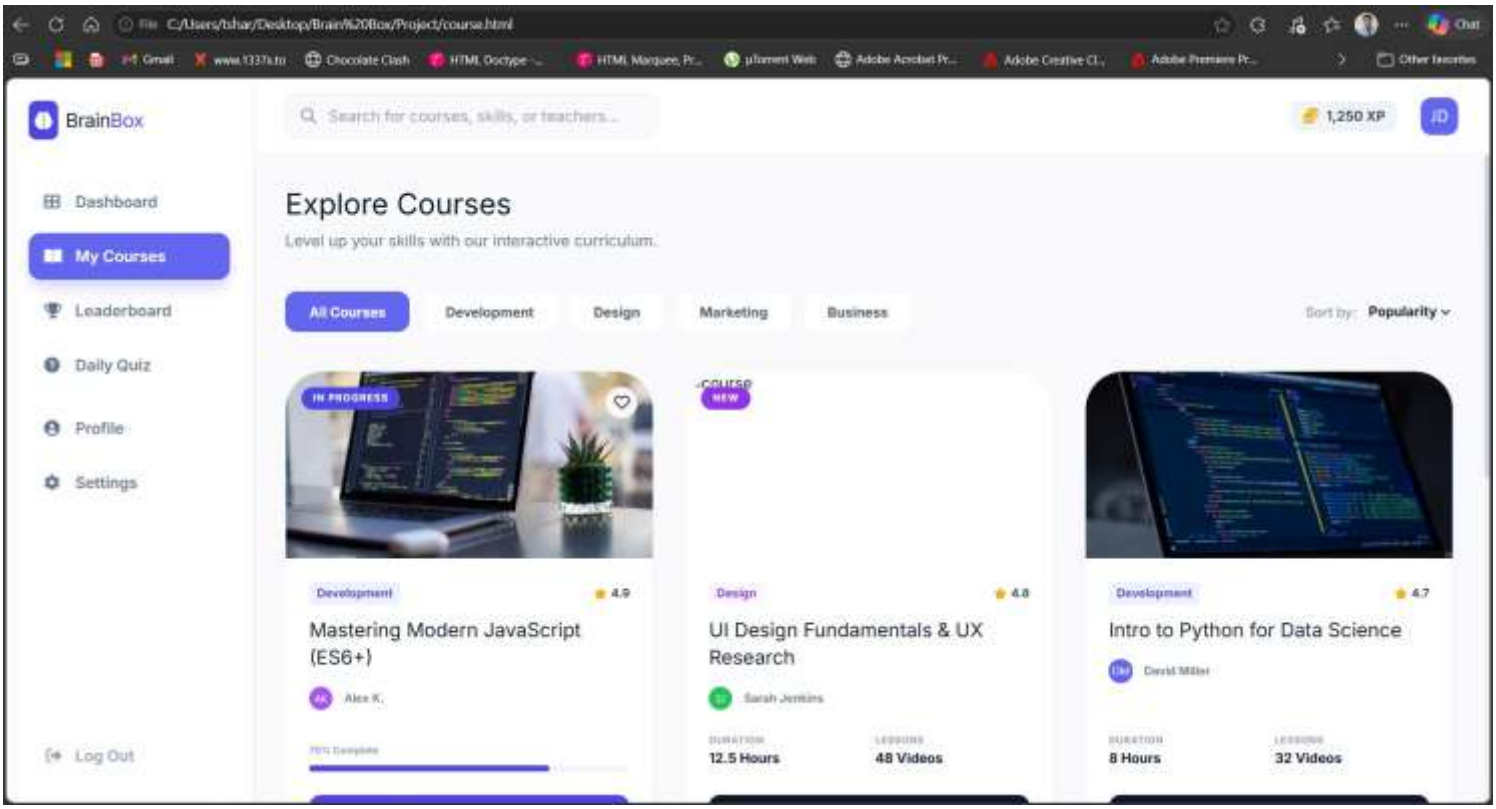

Fig. 4: BrainBox Course Catalogue UI — Explore Courses page with XP bar, category filters, and gamified course cards

A. Frontend Construction

The React frontend is organized into screen-level components — Login, Register, CourseCatalogue, ModuleViewer, QuizScreen, UserDashboard, AdminPanel — and smaller shared components like VideoPlayer, ProgressBar, BadgeTile, and LeaderboardRow. State is managed with useState and useEffect hooks. Redux was deliberately avoided as the state complexity did not justify the overhead.

The quiz screen took the most iteration. One question at a time is shown with four answer options rendered as buttons. After submission each option turns green or red. A summary screen shows the total score and, if the module is now unlocked, a continue button. An early per-question countdown timer was removed because timer state was not cleaning up properly on component unmount, causing stale intervals. It was replaced with a single overall session timer, which was stable.

B. Backend and API Structure

The Express server has four main route groups: authentication routes (registration, login, token-check), course routes (catalogues, module structure, video URLs), quiz routes (serve questions, accept POST submissions, return score and unlock status), and user routes (dashboard data, profile edits, leaderboard). Every route except public auth endpoints is wrapped in JWT middleware that verifies the token before any controller logic executes.

C. Problems Encountered

Video loading was the first performance issue — the YouTube embed was initializing on page load regardless of whether the user had navigated to a module. Lazy-loading the VideoPlayer component fixed this; it now only mounts when the module view actually opens.

A subtle race condition caused users who passed a quiz and immediately refreshed to sometimes see the next module still locked. The dashboard was occasionally responding before the progress write had committed. Adding a short delay before the post-quiz redirect resolved this.

V. RESULTS AND DISCUSSION

Forty-five undergraduate students participated in the evaluation across four weeks, divided into two groups — one using BrainBox and one using a standard LMS with the same video content but no quiz gate and no gamification. Table 3 summarises the findings.

Table - 3: Evaluation Results — Standard LMS vs. BrainBox

Metric	Std. LMS	BrainBox
Module completion	~40 %	~75 %
Session duration	12–18 min	30–40 min
Avg. quiz score	not tracked	75–85 %
Retry rate	N/A	~30 %
Satisfaction (/5)	3.1	4.5
Interaction mode	Passive	Active
4-week drop-off	High	Low–Moderate

The module completion gap was the standout result. The standard LMS group finished roughly 40 percent of assigned material — consistent with published data on open online course completion. The BrainBox group reached around 75 percent. The quiz gate is the primary driver: students could not advance without engaging, so passive click-through was not possible.

Session duration jumped from an average of 12 to 18 minutes in the control group to 30 to 40 minutes in the BrainBox group. Around 30 percent of quiz submissions were second or later attempts — and most of those students said informally that they had rewatched parts of the video before retrying. That is exactly the intended behaviour.

Quiz scores clustered between 75 and 85 percent. Several students flagged a few questions as ambiguously worded, which likely suppressed scores slightly — those questions have since been rewritten. User satisfaction averaged 4.5 out of 5. Positive comments mentioned the quiz interaction feeling more purposeful than typical online assessments, and the leaderboard creating genuine competition. Negative feedback focused on the absence of a hint system and some videos being too long without chapter markers.

Server performance was stable throughout: quiz evaluation responses averaged 250 to 300 ms and standard data requests came in under 200 ms. Pages loaded within two seconds on a typical 4G connection.

VI. CONCLUSION AND FUTURE SCOPE

The central question behind BrainBox was whether mandatory quizzes — rather than optional ones — would change how much students engaged with online course content. Over four weeks with 45 students, the answer was yes. Completion rates were close to double those of the comparison group. Sessions were longer. Students were retrying quizzes and going back to rewatch videos. The platform did what it was designed to do.

BrainBox is not a finished product at scale. The evaluation was small and the groups were not randomly assigned, which introduces selection bias. What it provides is a working prototype covering the full cycle — content delivery, mandatory assessment, gamification, and progress tracking — on a solid and maintainable technical base.

High-priority future improvements include automatic quiz generation from uploaded content, adaptive difficulty based on individual performance history, a native mobile application, and offline content access. Instructor-facing analytics — showing where students get stuck, which questions fail most often, and where drop-off occurs — would also add significant value. Live collaborative sessions and multilingual support are longer-term targets once the core product matures.

BrainBox makes a functional, evidence-supported case that structure and accountability in online learning are not just nice to have — they measurably change whether students finish what they start.

---***---

REFERENCES

[1] K. Jordan, "Massive open online course completion rates revisited: Assessment, length and attrition," Int. Rev. Research Open Distributed Learning, vol. 16, no. 3, pp. 341–358, 2015.
[2] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness: Defining gamification," Proc. 15th Int. Academic MindTrek Conf., Tampere, 2011, pp. 9–15.
[3] J. Hamari, J. Koivisto, and H. Sarsa, "Does gamification work? A literature review of empirical studies on gamification," Proc. 47th Hawaii Int. Conf. System Sciences, Waikoloa, 2014, pp. 3025–3034.
[4] M. D. Hanus and J. Fox, "Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance," Computers and Education, vol. 80, pp. 152–161, 2015.
[5] H. L. Roediger and J. D. Karpicke, "Test-enhanced learning: Taking memory tests improves long-term retention," Psychological Science, vol. 17, no. 3, pp. 249–255, 2006.
[6] P. Brusilovsky, "Adaptive hypermedia," User Modeling and User-Adapted Interaction, vol. 11, no. 1–2, pp. 87–110, 2001.
[7] K. Subhash and E. A. Cudney, "Gamified learning in higher education: A systematic review," Computers in Human Behavior, vol. 87, pp. 192–206, 2018.
[8] D. F. O. Onah, J. Sinclair, and R. Boyatt, "Dropout rates of massive open online courses: Behavioural patterns," Proc. EDULEARN14, Barcelona, 2014, pp. 5825–5834.
[9] I. Glover, "Play as you learn: Gamification as a technique for motivating learners," Proc. ED-MEDIA, Victoria, BC, 2013, pp. 1999–2008.
[10] C. Dicheva, C. Dichev, G. Agre, and G. Angelova, "Gamification in education: A systematic mapping study," Educational Technology and Society, vol. 18, no. 3, pp. 75–88, 2015.
[11] R. M. Ryan and E. L. Deci, "Intrinsic and extrinsic motivations: Classic definitions and new directions," Contemporary Educational Psychology, vol. 25, no. 1, pp. 54–67, 2000.
[12] N. Sclater, A. Peasgood, and J. Mullan, "Learning Analytics in Higher Education," Jisc, London, Tech. Rep., Apr. 2016.