Cloud based E-learning platform with Gamified Quiz

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***Abstract*—As education continues its gradual transition from physical to digital, and institutions increasingly offer learning outside of the classroom via online platforms, Still, improper utilization of it often leads students to passive participation, declining retention and in effect incapability to keep students engaged in classroom activities. This study aims to design an innovative learning management system in which interactive elements work for maximizing student engagement. Some of the key features of the system include pre-organised lectures, embedded quizzes in a game format and a performance leaderboard to drive healthy competition. The main goal is to analyze the effect of these interactive mechanisms on student motivation and overall learning effectiveness in the online context. This study intends to show that a properly designed learning management system has the potential not only to improve engagement, but also fundamental support in improving academic outcomes when it comes to distant learning.**

***Index Terms*—Learning Management System, Online Education, Student Engagement, Gamification, Interactive Learning, Digital Learning Platforms, Educational Technology, Virtual Classrooms**

I. Introduction

The move to online education over the course of the past few years has made a global impact on the learning experience. While this transition has certainly provided a measure of flexibility and accessibility especially with regards to education [7] — enhancing the use of online education to amazing levels [8] (due to global pandemic [9]) — it has also complicated the process of the lower levels of learner engagement and motivation in the virtual classrooms [10], [11]. A common limitation of traditional digital learning environments is that they do not bring the interactivity and engagement of a classical classroom, resulting in reduced learner engagement and academic performance [1], [9].

One of the most important things for online learning to work well is the availability of interactive tools and a learner-centered design structure [7], [12]. In order to solve these concerns, novel methodologies supported education like gamification and real-time association has been examined. Gamified learning, the infusion of game elements in instructional strategy has demonstrated an effective strategy to enhance the level of student engagement and the level of understanding in virtual lectures [1], [4], [6]. In addition, quizzes, leaderboards and achievement systems have been associated with increased learner motivation and retention [5], [8].

Cloud-based learning management system has been trending as an effective solution due to scalability, simplifying content distribution, and collaboration performance [2], [3]. But none or very few such platforms have the capacity to provide dynamic, feedback-driven experiences that can create the intrinsic learning motivation usually present in a physical classroom. The idea presented in this paper is to combine logically-shaped content with quizzes gamified and also the recording of students' achievement to create an interesting interactive learning environment in the form of a learning management system. The hybridization of these various methods is designed to provide a more efficient and qualitative online learning experience.

II. Literature Review

Recently, much research has already been done on the efficiency of digital quizzes in game format for online learning. In one study [1], researchers found that the integration of gamified features like points, levels, and competition in quizzes, substantially increases student engagement and knowledge retention. The exploratory mixed-method study showed that students engaged in gamification report higher levels of satisfaction and engagement, in addition to increased student performance in the course content.

Cloud-based learning management systems will often make up the foundation of an online learning platform. These systems are important in seamless access to course materials, supporting communication, and integrating external third-party tools, to customize learning [2]. Similarly, Anjum et al. [3] mentioned the use of cloud-based tools for collaborative and personalized learning by providing the possibility to monitor students in real time and adapt the instruction.

Gamification has been studied extensively as a pedagogical strategy in higher education according to Deterding et al [4]. By showing example, badges, leaderboards, and rewards, showed how they can exploit students' intrinsic motivations. However, they warned against excessive use that detracts from real learning objectives. Gamified learning environments improved academic outcomes if well-designed and focused on specific educational objectives [5].

Reinforcing this idea, Seaborn and Fels [6] conducted a review of several case studies where they found that gamification was beneficial for collaboration as well as engagement within students. In order for the game to make a positive long-lasting

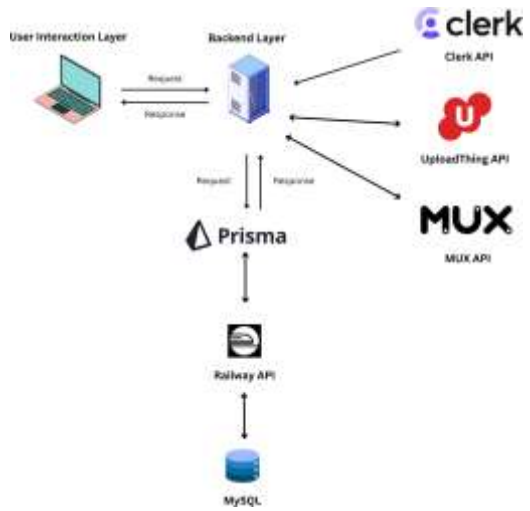

Fig. 1. System Architecture

impact, they emphasized that game elements must be aligned with the learning outcomes. Immersive learning tools with evidence of social and cognitive gains include synchronous quizzes and simulations. According to Mayer et al. [7], it helps students think deeply and engage with the content more in depth.

Wang [8] also explored the concept of real-time engagement for these blended lectures with the introduction of live quizzes such as Kahoot! [9] and replaces it with a set of exotic features that makes online learning fun, competitive, and what not which increases engagement and motivates students to pay attention to the topic!

In fact, the broader challenges of online learning are being addressed. Student disengagement is a prominent and widely cited issue (for example, see [10]) and several gamified features and interactive content are discussed as potential solutions to disengagement. An effective strategy for reducing dropout in long-term engagement seems to include gamifica- tion and peer interaction [11]. Most notably, Hrastinski [12] emphasized the importance of social presence in distance edu- cation, and pointed out that opportunities for peer interactions strongly improve the learning experience.

Together, these studies provide a rationale to develop an integrative gamified interactive learning management system with cloud-based architecture and real-time feedback systems to facilitate prolonged engagement and effective learning in virtual environments.

III. System Architecture

A. User Interaction Layer

User Interaction Layer — Responsiveness and interactivity: this is the first web layer that can be exported from your Learning Management System (Learning Management System) and is built using the latest frameworks like Next.js. End-users(students or instructor) can login to this interface and take action like browsing available course, /upload lectures/ take gamified quiz /check leaderboard standing. Every action that a user initiates is sent to the backend layer through an API request, which lays the foundation for dynamic interaction between the frontend and the core application logic.

B. Backend Layer

The Backend Layer; built using Next Also an entry point to request handling and application logic — API routes in next.js. It authenticates requests coming into the application, controls sessions, and handles interactions with all connected services. The Clerk API handles authentication and authorization making sure that users have first registered and verified themselves. After authentication, the user gets to the course management, video play, quiz participation, and leaderboard. It also takes care of communication for Prisma ORM, UploadThing, and MUX to coordinate data and media streaming.

C. Ingestion and Streaming

For example, when teachers upload lecture videos or media resources, the backend calls the UploadThing API to upload files to cloud-based storage. Next, we transfer those uploaded assets to MUX (A video streaming as a service that encodes videos to multiple adaptive bitrate formats so that we can keep smooth playback regardless of changing network conditions). For every video that MUX processes, it returns a streaming URL that the backend saves in the database for later. The front end then fetches and renders this URL for the students to watch it from inside the Learning Management System window.

D. Using Prismatic and Railway for the Database

We used Prisma ORM to manage data persistence (the abstraction above the plain SQL to interact with a MySql database hosted at Railway). This relational database contains and manages all the critical data—like profiles for users, metadata about courses, URLs for videos, quiz questions, answers, and scores from quizzes. Prisma simplifies complex data operations and allows for clean, and reliable data access patterns that enable scalable and maintainable Learning Management System backend services.

E. A gamified quiz and leaderboard system

Gamified quiz engine — this is one of the core engagement features of the Learning Management System. The backend instantaneously evaluates the responses, as students take quizzes. Scores are computed in real-time and saved in a database. These scores will generate user rankings that appear on a leaderboard, giving a competitive and motivating environment. The system continuously updates the leaderboard upon sub- mission of new quizzes, keeping the students updated on their performance compared to other peers. This way interactions and performance among the students can be improved.

IV. Web Technologies and Services

A. Next.js - Front & Back end Framework

Next. Next.js: A full-stack framework based on React used to create the frontend UI as well as the backend API routes of the LMS. This means server-side offering, Static site generation, and routing as built-in which enhances the performance and the SEO of the application. It serves as the back bone for interfaces, video streaming, quizzes, and leaderboards on the frontend.

B. Clerk - Authentication & Authorization

Clerk allows the LMS to implement secure, scalable, and dev-friendly authentications. It offers out-of-the-box components for login, registration, and managing user profiles as well as role-based access control. This integration with Clerk guarantees that access to sensitive data (like uploading content or attempting quizzes) is done by authenticated users only, in the LMS. Clerk also offers OAuth, 2FA, and JWT-based sessions.

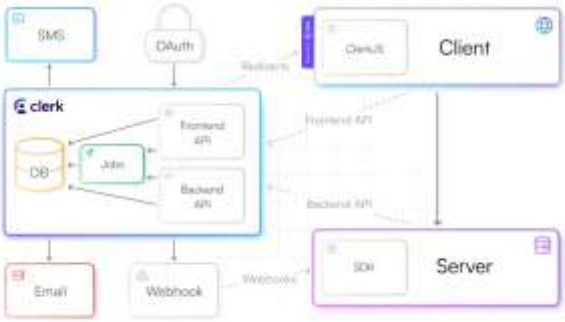

Fig. 2. Clerk Authenticator Architecture

C. Prisma - Database ORM

A free and open-source ORM tool that helps develop and manage MySQL databases quickly and easily. It boasts a higher-level abstraction for data querying / data manipulation with type safety and better maintainability. Bring in Prisma that abstracts everything away from us: creating a course, saving quiz results, fetching user progress and so on. It helps in handling schema migrations and provides efficient and secure communication between the application and the database.

D. Railway - Database Hosting Platform

A cloud platform for deployment and hosting of MySQL database supporting the Learning management system. It abstracts the infrastructure layer and offers a developer experience to deploy scalable and reliable database solutions. By using Railway with the LMS, our LMS inherits automated backups, env variable management, and instant deploy so we can iterate on development quicker and have our entire solution production ready.

E. MySQL - Relational Database Management System

As the main relational database for structured data such as profiles, courses, quiz questions, scores and leaderboard, we use MySQL. High performance, reliability, and ACID compliance, fit for LMS applications that require consistency, structured querying, and transaction need to be managed.

F. UploadThing - Media Upload Service

UploadThing is a modern, easy-to-use file upload API. It is utilized mostly by teachers to upload lecture videos and documents in the LMS to further integrate our studies. UploadThing handles your upload process with validation, type-checks, and delivers everything securely to your cloud storage. It integrates to backend perfectly and that also directly uploaded from browser to your website and can improve user experience and also speed performance.

G. Mux - Video Encoding and Streaming Platform

Mux is a robust video platform for encoding, storage, and streaming of lecture videos. Each time a video is uploaded through UploadThing, that video is sent to Mux for processing. Mux encodes the video into adaptive streaming formats, adapting the playback to a variety of devices, and network conditions, delivering the best playback experience possible. It will provide a streaming url, which will get stored in the database, and will be rendered on frontend for video delivery.

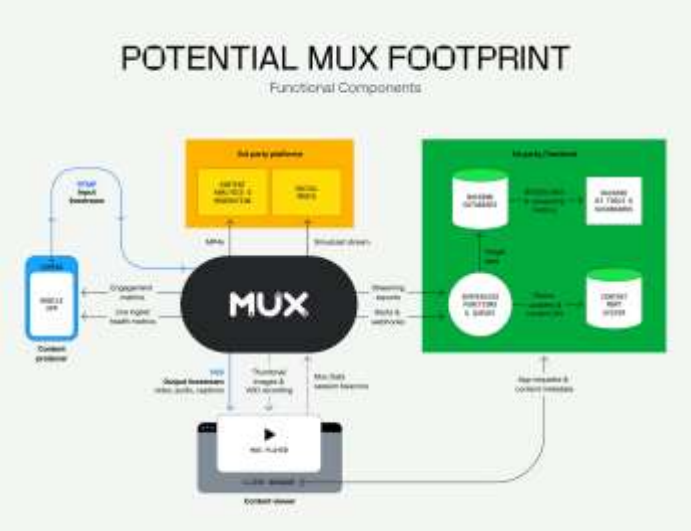

Fig. 3. MUX API Architecture

H. Styling Framework — Tailwind CSS

We use Tailwind CSS for styling the frontend of the LMS. It enables fast development of responsive and accessible UI without having to write any custom CSS. Tailwind ensures the UI is consistent across normal looking components like dashboards, quiz interfaces, and video players.

I. ShadCN/UI - UI component library

ShadCN/UI: A set of components and templates that embrace modern design. This means it helps with the development of complex Frontend components like modals, cards, buttons, dropdowns, etc. to speed up the UI development and makes sure there are visual similarities across the application.

J. OpenAI API - AI Model

OpenAI is an API that assists us to include natural language intelligence to our LMS. It gives a access to the state-of-the-art LLM like GPT-4, which have been developed to understand and generate human-like text. Yes, OpenAI is working to ensure that AGI benefits the whole of humanity, and the best way to do that is to train its models on the largest and most diverse datasets the internet can offer.

The LLMs are trained to learn the structure, meaning, and the flow of human language in a given context, hence, they can understand an input (prompt) in addition to a context and can provide a meaningful coherent response. At their core, they use billions of parameters and deep learning to predict the next most logical piece of text given the input.

In our LMS, we use this capability to dynamically generate quiz content. For each course, the API is called using the course title as input, and in return, we receive a set of quiz questions along with their correct answers—created entirely by the model in real time.

Hence, it is highly time-saving for teachers as they can avoid the laborious process of creating their quizzes from scratch and receive customized course-specific content on a plate. Because the API communicates via basic HTTP requests, we are not on the hook for spinning up or maintaining the AI models on our servers! It all takes place in the cloud, and we merely pull down the events when required. Not just does it speed up content generation, but it also brings another level of intelligence in the platform, making the learning process the subject-based content far more interactive, scalable, and engaging for students and instructors alike.

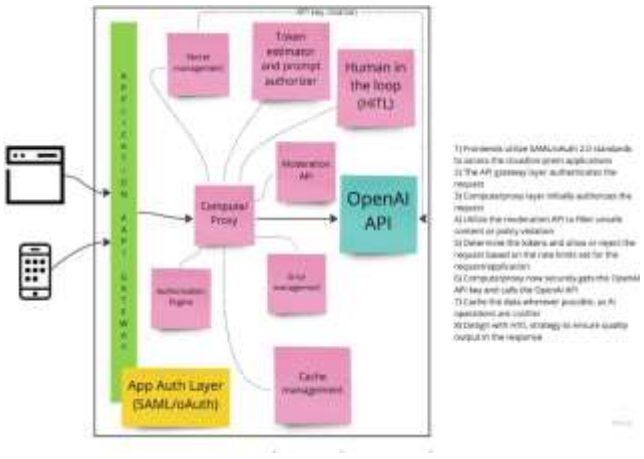

Fig. 4. OpenAI API Architecture

V. FEATURES IMPLEMENTED

A. Dashboard

The dashboard acts as the centralized hub for users, displaying personalized course recommendations, progress tracking, and quick access to recently accessed modules. It provides a clean and intuitive interface that enhances user navigation and engagement from the moment of login.

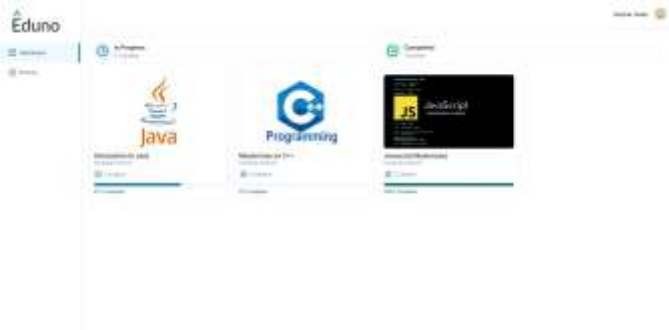

Fig. 5. Dashboard

B. Course Creation

Designed for instructors, this page facilitates the streamlined creation and publication of course content. Users can upload lecture videos, add descriptions, structure modules, and integrate quizzes. It ensures efficient content delivery while maintaining a clear and organized course flow.

Fig. 6. Course Creation

C. Course Page

The course page allows students to access detailed learning materials, including lecture videos, documents, and associated quizzes. It tracks completion status and provides a structured layout for seamless content consumption.

Fig. 7. Course page

D. Quiz Instruction

Before attempting a quiz, students are presented with a clear set of instructions outlining rules, time limits, and scoring criteria. This modal ensures clarity and fairness, preparing students for the assessment environment.

Fig. 8. Quiz Instruction

E. Quiz

This interface delivers a gamified quiz experience with multiple-choice questions generated dynamically. It includes real-time response validation and seamless navigation, aimed at enhancing learning through interactive assessments.

Fig. 9. Quiz

F. Leader board

The leaderboard ranks students based on their quiz performance, fostering a competitive learning atmosphere. It updates in real-time and encourages consistent participation and improvement through visible recognition.

Fig. 10. Leader board

VI. Result

The implemented E-learning management system was explored for functionality, user experience, and engaging features across multiple modules of testing–course creation, content delivery, and gamifying assessments.

The feedback from a subset of individuals (students and faculty) when initially tested provided significant improvements in participation and engagement levels compared to prior LMS interfaces. A gamified quiz assessment was a favored example in this regard with many noting it was a more competitive and fun way to turn individual assessment into a more fun experience, as evidenced by continued leader board engagement. Instructors found it easy to upload and maintain course content through a single screen for seamless organization.

It was noted that AI-generated quiz content performed adequately and came with the added benefit of cutting down time spent creating question sets, as it was shown to perform effectively.

VII. Future Work

A. Integrating AI-Powered Tutoring Assistant

We are looking to implement an AI-based chatbot in future iterations, which would provide a real-time, context-aware assistant for students when they are attempting the course, or while taking the quiz. This would function as a virtual tutor, where it could provide hints, explanations, or resources when based on what the user is doing, and what questions they are asking.

B. Adaptive Learning Pathways

The real opportunity would be to implement adaptive learning and allow the course to be custom spaced on student performance. Also, with adaptive learning, the platform would be able to adapt quizzes on the fly (upward or downward) or recommend remedial modules. Overall, adaptive learning can allow for a much more individualized learning experience.

C. Peer-to-Peer Learning Modules

A discussion forum and peer mentorship function could significantly improve not just collaboration but provide students a venue to ask questions and interact with each other by sharing knowledge or grouping to create study groups from the Application to engage in following an active peer-based learning practice.

D. Gamified Certification and Reward System

Badges, certificates, or points benefits for regular use of the Application could also support, encourage and reward engagement. These rewards can be tied to milestones like completing a course, streaks in quizzes, or a leader board ranking.

VIII. Conclusion

This paper describes a cloud-based online learning management system with gamification elements designed to improve student engagement, motivation, and performance during online learning. By integrating structured course delivery with video in real time, AI generated quizzes, and a competitive leaderboard, we are hoping to replicate the interactive experience of a physical classroom.

The excellent web technologies used in our design will always assist us with scalability, connectivity, and data security. In summary, we show how an appropriately designed learning management system can be a powerful platform for online education, particularly in cases when other methods of engagement are not as effective. Future development plans for the platform include AI tutoring, adaptive learning, and peer-culminated learning. These potential improvements afford the great potential to take this to the next level and into a prolonged widely relied, and potentially ubiquitous, digital learning system.

References

[1] K. Pireva Nuci, R. Tahir, A. I. Wang, and A. S. Imran, "Game-based digital quiz as a tool for improving students' engagement and learning in online lectures," in *Proc. IEEE*, 2023.

[2] S. Alajmi, "Cloud-based LMS platforms: The key to effective online learning," in *Proc. Int. Conf. Educational Technologies (ICET)*, Kuwait City, Kuwait, 2020.

[3] T. Anjum, F. Rahman, and P. Singh, "Cloud-based education tools for collaborative and personalized learning," in *Proc. IEEE Int. Conf. Computing, Communication, and Security (ICCCS)*, Patna, India, 2020.

[4] S. Deterding, L. Dixon, R. Khaled, and C. Nacke, "The impact of gamification on student engagement in higher education," in *Proc. IEEE Global Eng. Educ. Conf. (EDUCON)*, Vienna, Austria, 2021.

[5] J. Hanus and T. Fox, "Gamified learning environments: An analysis of student engagement and performance," in *Proc. Int. Conf. Educational Research and Innovation (ICERI)*, Barcelona, Spain, 2021.

[6] R. Seaborn and D. Fels, "Gamification in education: Case studies and analysis," in *Proc. IEEE Frontiers Educ. Conf. (FIE)*, Lincoln, NE, USA, 2022.

[7] J. Mayer, A. Jones, and M. Smith, "The cognitive benefits of interactive learning tools in online education," *IEEE Trans. Educ.*, vol. 64, no. 3, pp. 281–290, 2021.

[8] H. Wang, "Real-time interactive quizzes for active learning in online classes," in *Proc. Int. Conf. Interactive Collaborative Learning (ICL)*, Tallinn, Estonia, 2020.

[9] D. Pe´rez, L. Martinez, and J. Garc´ıa, "The role of interactive tools in enhancing student engagement in virtual classrooms," *IEEE Access*, vol. 10, pp. 90215–90226, 2022.

[10] B. Means, Y. Toyama, and M. Murphy, "Online learning: The challenges and solutions for engagement," in *Proc. IEEE Int. Conf. Adv. Learn. Technol. (ICALT)*, Tartu, Estonia, 2020.

[11] A. Bakia, J. Shear, and M. Woodruff, "Addressing long-term engagement challenges in online education," in *Proc. Int. Conf. Learn. Technol. Digital Learn. (LTDL)*, Paris, France, 2021.

[12] U. Hrastinski, "The role of social presence in online learning for engagement," *IEEE Trans. Learn. Technol.*, vol. 13, no. 4, pp. 658–667, 2020.