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Tackling Distractions In Online Learning Through Gamified Educational Platform

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Abstract: Technology has advanced rapidly in recent years. This has been a godsend for the people, making their lives easier. The advancement of technology has a significant impact on students. This has revolutionised the way students learn, providing them with access to vast amounts of information and resources. Remote study is now possible for anyone who has a digital device like a mobile or a laptop and an internet connection. While technology has many benefits for students, it can also be a major source of distraction. The constant influx of notifications and updates might make concentrating on activities and assignments difficult. When working on a laptop, multitasking is simple, such as flipping between tabs for different purposes or opening undesired applications during productive time. This takes up most of the student's considerable time, which could be better spent studying and learning. To address the challenge of distractions and disengagement in online learning, we propose a gamified educational web application that combines video lessons with interactive quizzes. Our platform is designed to enhance student focus, motivation, and retention by incorporating game-like elements such as rewards, progress tracking, and leaderboards. This solution aims to change how students engage with online educational content by creating a more interesting learning experience. By embedding quizzes within the video content and rewarding focused engagement, the application keeps learners actively involved and motivated throughout their educational journey. This innovative approach is aimed at improving focus, retention, and overall academic performance, offering a dynamic learning environment that not only helps students manage distractions but also enhances the quality of online education. The solution is poised to benefit students, educators, and institutions alike, potentially reshaping the future of e-learning. Our approach with this gamified educational platform is significant because it addresses a key issue that many existing online learning solutions fail to tackle: student engagement and focus. Traditional e-learning platforms provide access to content but often overlook how students interact with that content, especially when they are bombarded with distractions. By embedding quizzes directly within the video lessons, we ensure that students stay actively involved rather than passively consuming information. This solution has the potential to extend its impact beyond individual students, transforming how educational institutions deliver online content by making it more interactive, engaging, and tailored to student needs.

Index Terms - technology advancement, online learning, remote study, distractions, multitasking, gamified, interactive quizzes, retention, active learning, e-learning, student-centered education.

I. INTRODUCTION

The Covid-19 pandemic served as a catalyst for the rapid adoption of online education, fundamentally altering traditional teaching and learning practices [1]. This transition has brought both opportunities and challenges, with significant implications for how knowledge is accessed, shared, and evaluated. On the one hand, online education offers unparalleled flexibility and accessibility, enabling learners to participate from virtually anywhere. On the other hand, it has raised concerns about reduced student engagement, academic

performance, and social development, as virtual classrooms often lack the structured environments necessary to maintain focus and motivation [2,3].

One of the most prominent challenges in online learning is the issue of distractions. With the convenience of online platforms comes the constant lure of social media, messaging applications, and readily available entertainment, which interfere with students' ability to stay focused for extended periods [4]. These distractions not only disrupt learning but also impact students' ability to retain

information, compounding the long-term effects on their educational outcomes [5]. Reports highlight that maintaining sustained engagement in virtual learning environments is a growing concern, with students increasingly experiencing apathy, reduced motivation, and a lack of direct interaction after the initial novelty of online learning subsidies [2].

The scale of online learning adoption underscores the importance of addressing these challenges. For educators, the shift to online teaching posed significant difficulties, requiring rapid adaptation to unfamiliar platforms, addressing technical disruptions, and finding new ways to engage students remotely [6]. Traditional teaching strategies often proved inadequate in maintaining student engagement in virtual settings, leading to calls for more interactive and innovative approaches [7]. Effective strategies, such as gamified activities, small group discussions, and personalised feedback, have been found to enhance student motivation and engagement in these environments [8].

Gamification has emerged as a promising pedagogical approach to address the issue of student disengagement and distractions in online learning. Gamification integrates game-like elements into non-game contexts, leveraging points, badges, leaderboards, and progress bars to create a more engaging and interactive experience [5,9]. This approach is particularly effective in fostering motivation and focus by incorporating interactive quizzes, challenges, and rewards, strategically placed throughout course content to sustain interest [10,11]. By providing a sense of accomplishment and positive reinforcement, gamified platforms can enhance learning outcomes, mitigate distractions, and promote productivity [12,13].

This paper proposes a gamified educational platform designed to combat the challenges of online learning, such as distractions and apathy. The platform will integrate interactive features like quizzes, leaderboards, streaks, and point-based rewards to create an engaging and immersive learning experience. Additionally, the platform will cater to educators by offering an intuitive course creation interface, enabling them to design and deliver content seamlessly. By bridging the gap between engagement and education, this gamified solution aims to redefine the future of online learning, ensuring students remain focused, motivated, and productive in virtual environments. Through its dual focus on learner engagement and educator empowerment, the proposed platform aspires to address the limitations of current online learning models and contribute to the ongoing evolution of education in the digital age.

II. LITERATURE REVIEW

The role of gamification in enhancing students' critical thinking and engagement is evident in various educational settings. A study in 2023, focused on using a serious game to educate young people on the phenomenon of fake news [18]. This study emphasised the importance of critical thinking skills, especially in navigating information on social media. By involving 217 middle school students in interactive workshops, the game allowed students to assess the authenticity of the news, facilitating discussions and curiosity around the subject matter. The findings indicated that integrating game-based learning in the classroom could foster a deeper understanding of complex topics like logical fallacies and cognitive biases, making learning more engaging and interactive for students. The teacher's ability to monitor activities through detailed reports also enabled tailored guidance, further enhancing the educational experience.

Another study in 2020 explored the impact of gamification on students' engagement, learning behaviour, and performance in a web-based programming environment [19]. The experiment involved 40 undergraduate students, who were divided into two groups: one using a gamified version with features like points, badges, and leaderboards, and the other using a non-gamified version. The study revealed that gamification positively influenced student engagement, but the effectiveness varied significantly based on individual personality traits. While some students responded positively to competitive elements, others found them less motivating. This study underscores the need to consider user-specific factors when designing gamified learning platforms, as a one-size-fits-all approach may not yield optimal results. The tailored approach helped ensure that gamification contributes meaningfully to the learning experience by aligning with users' preferences and characteristics.

A large-scale study in 2023 examined the effectiveness of game-based learning in programming courses, targeting both undergraduate and postgraduate students [20]. The research aimed to address the challenge of disengagement in STEM subjects, particularly in fields like computer science. The study introduced a series of serious games designed to visualize programming concepts in interactive and enjoyable ways, helping students grasp abstract topics. Through a comprehensive assessment involving surveys, observations, and interviews, the researchers found that game-based learning significantly enhanced students' understanding and confidence in programming. Notably, the games proved beneficial across diverse student demographics, although the extent of their impact varied depending on factors like students' prior exposure to technology and educational background. This study highlighted the potential of gamification to bridge the gap between traditional teaching methods and the need for more engaging, technology-driven educational tools.

III. PROPOSED SOLUTION

As established in the literature review, distractions and multitasking significantly hinder online learning. Gamification has emerged as a promising approach to address these challenges. Building on this understanding, we propose the development of a gamified e-learning platform designed to mitigate these issues. The platform we propose will incorporate various gamification elements, such as quizzes, leaderboards, and competitions, to engage learners and minimize distractions. By integrating these features, we aim to enhance the learning experience and improve learner outcomes.

A key feature of the proposed platform is the integration of quizzes directly within video content at specific timestamps. Course creators will have the ability to embed interactive questions, such as multiple-choice or fill-in-the-blank questions, at predetermined points during their video lectures. These in-video quizzes are intended to maintain learner focus, test comprehension in real-time, and break up long sessions of passive watching, thereby reducing cognitive fatigue and promoting active learning.

To ensure a high standard of educational content, we plan to create and upload a series of benchmark courses ourselves. These initial courses will serve as a model for best practices, setting a standard for the quality, structure, and gamification elements that other courses should follow. Furthermore, all courses submitted by external creators will undergo a verification and approval process. This process will ensure that the content aligns with the platform’s standards and fully leverages the gamified features, such as quizzes and streaks, to foster an engaging and effective learning environment.

The gamified e-learning platform will be designed to create an engaging and interactive learning environment. By integrating features such as quizzes, leaderboards, and streaks, the platform will foster a sense of competition and motivation among learners. These elements are strategically implemented to encourage active participation, reduce distractions, and enhance focus.

The proposed platform architecture will consist of two main components: a content creator interface and a learner interface. The content creator platform will enable educators to design and manage engaging educational content, including interactive quizzes and challenges. Meanwhile, the learner platform will provide users with a personalized learning experience, tracking their progress, awarding points, and displaying their achievements on leaderboards.

In addition to gamification, the platform will employ a comprehensive analytics system to monitor learner behaviour and engagement. This data-driven approach will support the continuous improvement of the platform by identifying areas where learners might face difficulties or lose motivation.

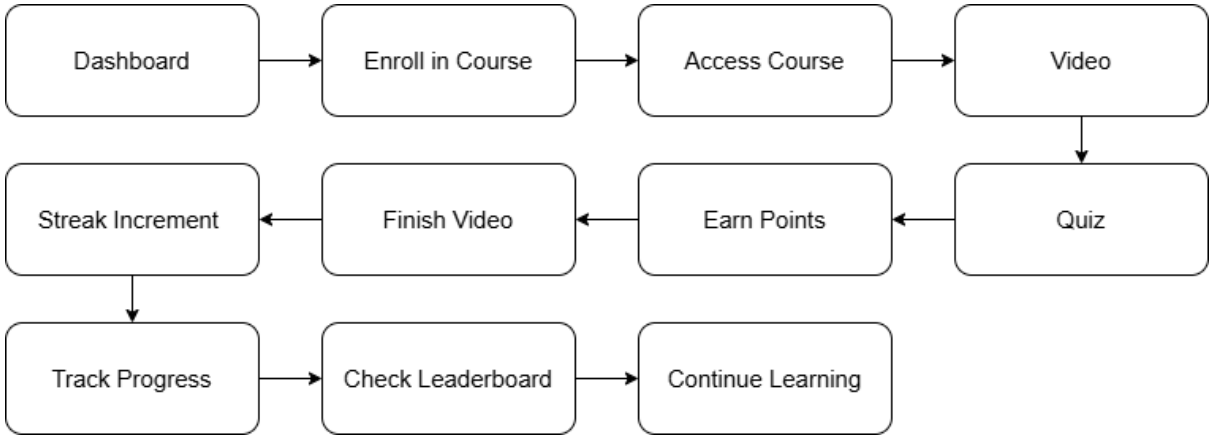

figure 1. learner block diagram

The learner's journey on the gamified education platform is visually represented in the block diagram *figure 1*. It outlines the sequential process and interactive features designed to enhance engagement and minimize distractions during online learning. The process begins at the Dashboard, where learners can explore available courses. Upon selecting a course, they proceed to the Enroll in Course step, enabling them to gain access to the course materials. Once enrolled, learners transition to the Access Course phase, which directs them to a structured sequence of video lectures. Videos are equipped with interactive elements, including embedded quizzes, at predefined timestamps specified by the course creator. Learners engage with the video content and are prompted to complete integrated Quizzes, such as multiple-choice questions or fill-in-the-blank tasks. Successful quiz completion awards learners Points, which act as motivational incentives. After earning points, learners mark the video as completed, triggering the Finish Video step. Completing videos also contributes to their Streak Increment, which tracks daily engagement and further incentivizes consistent learning behaviour. Learners can monitor their overall progress via the Track Progress feature, which aggregates key metrics, including streaks, completed courses, and accumulated points. Learners are encouraged to engage with peers through the Check Leaderboard feature, fostering healthy competition and social motivation. This leaderboard showcases rankings based on streaks, points, and overall activity. Finally, learners are guided to Continue Learning, promoting an iterative process of acquiring knowledge and maintaining progress within the platform. This modular and gamified approach ensures an interactive, rewarding, and distraction-free learning environment for learners. Each component is designed to provide immediate feedback, encourage habit formation, and maintain sustained interest in the educational content.

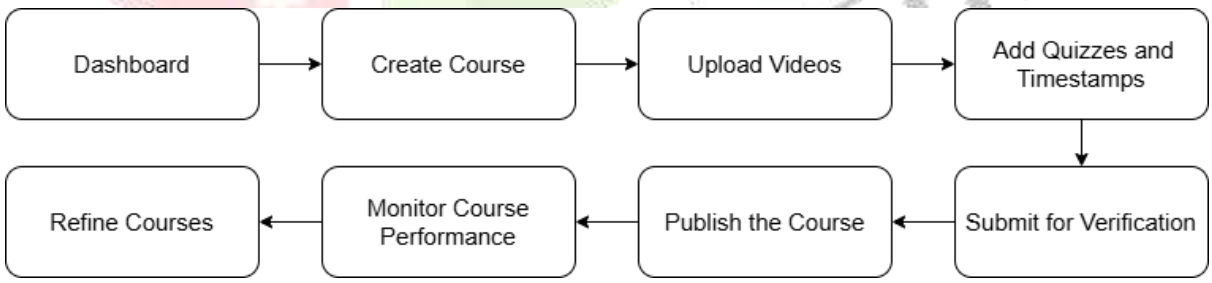

figure. 2. creator block diagram

As shown in figure 2, the systematic process for creating and managing courses on a gamified educational platform. It begins with the Dashboard, where educators can access tools to initiate course creation. The subsequent step, Create Course, allows the structuring of the course framework. Next, instructors Upload Videos to provide core learning content, followed by adding Quizzes and Timestamps, which enhance interactivity and ensure learners engage with specific content sections. Once this is complete, courses are Submitted for Verification, ensuring compliance with platform standards. After verification, educators can Publish the Course, making it accessible to students. Post-publication, instructors can Monitor Course Performance through analytics, allowing insights into learner progress and engagement. Finally, the cycle concludes with Refine Courses, where feedback and performance metrics are used to improve the content, maintaining relevance and effectiveness. This flow ensures a streamlined, iterative process for course management, prioritizing quality and learner engagement.

Overall, we propose that the combination of gamification techniques and robust analytics in our platform will significantly improve the online learning experience, addressing the issues of distraction and multitasking highlighted in the literature review.

3.1 Gamification Techniques

To enhance engagement and minimize distractions, our platform integrates several gamification techniques, including leaderboards, streaks, and interactive quizzes. These elements are designed to motivate learners by introducing a sense of achievement and competition.

1) Quizzes: The platform allows content creators to incorporate quizzes at strategic timestamps throughout the course material. This feature helps break down the learning process into manageable sections, keeping learners focused and engaged [5,13]. Quizzes can include various types of questions such as:
Multiple Choice: To assess understanding of key concepts.
Fill in the Blanks: To test recall and application of specific information.
True/False: To quickly evaluate comprehension of facts.
Match the Following: To connect related concepts, enhancing deeper learning.

By including these quizzes at specific intervals, learners are periodically reminded to refocus on the content, helping to mitigate the risk of distractions.

2) Competitive Quizzing: A unique aspect of the platform is its real-time, competitive quizzing feature. Learners can initiate a quiz and invite others to participate simultaneously. This timed, group-based approach encourages active engagement, as participants answer questions in real-time and compete to achieve the highest score. The competitive nature not only makes learning fun but also fosters a collaborative environment where participants strive to perform better [5,9].

3) Leaderboards and Streaks: To maintain motivation over time, the platform employs leaderboards to display the top performers and recognize consistent learners. Streaks encourages learners to engage with the content regularly, reinforcing good study habits. By visually tracking progress and offering rewards for maintaining streaks, learners are less likely to disengage or become distracted [17]. These gamification techniques work collectively to create an immersive and interactive learning experience. By integrating quizzes at critical points, offering real-time competitive play, and providing continuous feedback through leaderboards and streaks, the platform aims to reduce distractions and keep learners on track throughout their learning journey. [11,12]

3.2 Learner Level Metric Algorithm

The Leaderboard System is built on algorithms and mathematical models to ensure a fair and dynamic ranking mechanism for learners. It leverages multiple performance factors, such as recent quiz scores, course difficulty, and user engagement, to compute a comprehensive **Learner Level Metric (LLM)**. Learners are then grouped into competitive tiers using clustering techniques, promoting fairness by matching individuals with similar skill levels. Rankings are periodically updated based on performance, fostering a sense of progression and competition. These models enhance the gamified learning experience by motivating learners to achieve higher levels of engagement and performance.

1) Define the Learner Level Metric (LLM)

Compute a score for each learner using a weighted combination of factors. For example:

i. **Recent Performance Score (RPS):** Weight on recent quiz marks and streaks
ii. **Difficulty Score (DS):** Weight on the difficulty level of units being studied.
iii. **Quiz Performance Score (QPS):** Weight on cumulative or average quiz marks.
iv. **Engagement Score (ES):** Weight on streaks, time spent, and completion rates.

Formula (example):

$$LLM = w_1 \cdot RPS + w_2 \cdot DS + w_3 \cdot QPS + w_4 \cdot ES$$

Weights (w_1, w_2, w_3, w_4) can be adjusted to prioritize certain aspects.

2) Normalize Scores

i. Ensure fairness by normalizing each component before combining:
ii. Use min-max normalization:

$$Normalized\ Equation\ = \frac{Learner\ Score\ -\ Min\ Score}{Max\ Score\ -\ Min\ Score}$$

3) Cluster Learners into Groups

i. Use clustering algorithms (e.g., K-Means, DBSCAN) to group learners with similar LLMs.
ii. **Input**: Normalized LLMs of all learners.
iii. **Output**: Clusters of learners with similar levels.

Each cluster represents a leaderboard tier, ensuring fairness in competition.

4) Calculate Rank Within Each Cluster

i. Sort learners within each cluster based on their raw LLM or specific criteria (e.g., recent performance).
ii. Assign ranks accordingly.

5) Update Leaderboard Periodically

i. **Dynamic Updates**:
Recompute LLMs at regular intervals (e.g., daily or weekly).
ii. Re-cluster learners and recalculate ranks to reflect current performance.
iii. **Streak Handling**:
Provide bonus points for maintaining streaks or completing milestones.

6) Integrate Leaderboard into the Platform

i. Frontend:
a) Display leaderboard tiers based on clusters.
b) Highlight top learners in each tier and incentivize progression to higher tiers.

ii. Backend:
a) Store LLM and cluster information in MongoDB.
b) Use a caching mechanism (e.g., Redis) to handle frequent leaderboard requests efficiently.

Example Algorithm Workflow

i. Input Data:
Recent quiz marks, difficulty levels, engagement metrics, streak data.

ii. Normalize Scores:
Normalize each factor (e.g., quiz marks out of 100, difficulty levels scaled to 1-5).

iii. Compute LLM:
Combine normalized scores using predefined weights.

iv. Cluster Learners:
Group learners into clusters using a clustering algorithm.

v. Rank Learners:
Sort learners within clusters to assign ranks.

vi. Store & Serve:
Save leaderboard data (clusters, ranks) in MongoDB for retrieval.

vii. Fairness & Scalability Enhancements

A. Dynamic Weights:
Adjust weights over time based on user feedback or platform goals.

B. Adaptive Clustering:
Use an adaptive algorithm (e.g., varying cluster sizes) to balance group sizes.

C. Gamification Elements:
Reward badges, extra points for maintaining top ranks, or surpassing streak milestones.

3.3 System Architecture and Technology Stack

The proposed architecture for our is designed around **Next.js** and **MongoDB**, allowing us to build a robust e-learning platform with real-time interactions, dynamic content, and server-side rendering for a seamless and optimized user experience.

1. Frontend and Backend: The platform will be built using Next.js, a versatile framework that seamlessly integrates frontend and backend functionalities. Optimization techniques such as internalisation support and reduced JavaScript bundle size improve the user experience by providing faster page load times and a smoother, more seamless browsing experience [14]. Next.js's advanced features, including server-side rendering (SSR) and static site generation (SSG), will significantly enhance performance and SEO, resulting in a dynamic, responsive, and high-performing user interface. The framework will enable the development of reusable components, such as quiz modules, leaderboards, and the user dashboard, streamlining the overall development process. Essential features like real-time quiz participation, score updates, and streak tracking will utilize Next.js's robust server-side capabilities and state management, ensuring a seamless and engaging user experience.

2. Backend APIs: Using Next.js API routes, the backend will handle API requests, user authentication, and real-time quiz functionalities. This unified architecture removes the need for a separate Express server, as Next.js will manage both frontend components and backend services. The design includes RESTful APIs to manage data like user profiles, quiz content, scores, and leaderboard statistics. Additionally, the platform will support real-time interactions, such as real-time invitations and responses for competitive quizzes, allowing simultaneous participation among users.

3. Database: MongoDB is chosen as the database for storing diverse data, including user information, quiz questions, timestamps, scores, and leaderboard statistics. The JSON format of data stored in MongoDB helps in analysing the data easily for further processing [15]. This suits the dynamic and varied data formats expected on the platform, such as different question types (e.g., multiple choice, fill-in-the-blanks) and time-bound quiz sessions.

4. Real-Time Interaction: To support the real-time competitive quiz feature, we plan to use WebSockets through libraries like Socket.IO within the Node.js environment. This will enable instant communication between participants, providing real-time score updates and determining winners promptly to ensure an engaging experience.

5. Hosting and Deployment: The platform will be deployed on cloud services like AWS, providing a scalable and secure environment to support the Next.js and MongoDB architecture. Utilising AWS S3 for video storage ensures reliability and scalability, accommodating creators with varying content [16].

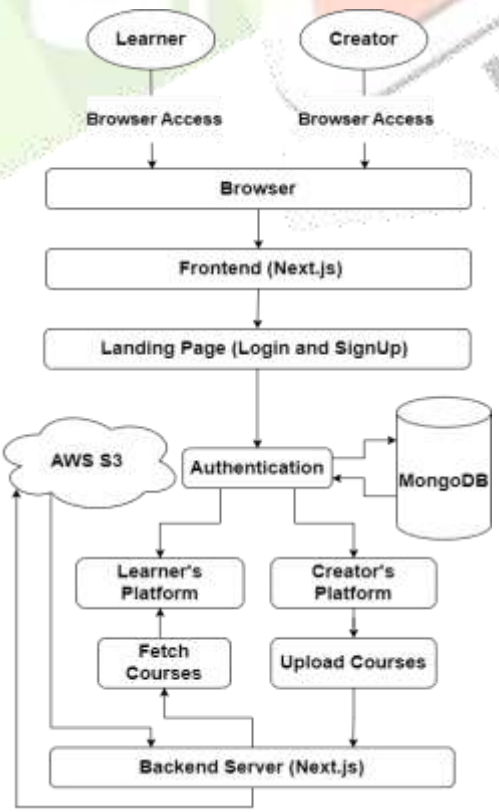

figure 3: proposed system architecture of the gamified e-learning platform

The architecture, as depicted in figure 3, outlines the interaction between the tech stack components and how they support the platform's functionalities. The platform's architecture revolves around Next.js and MongoDB, providing a unified and scalable solution that ensures an engaging, real-time user experience with efficient data management. With built-in features like SSR, SSG, and real-time capabilities, the platform will support dynamic interactions while maintaining a smooth and responsive interface

IV. KEY CHALLENGES AND CONSIDERATIONS

Developing the proposed gamified e-learning platform using the MERN stack comes with several key challenges:

1. Real-time Data Handling: Implementing features like competitive quizzing and instant leaderboard updates requires efficient real-time data handling using technologies like WebSockets. Ensuring seamless interaction among multiple users without lag will be a significant technical challenge.

2. Scalability: As user numbers grow, the platform must be capable of handling increased data and activity. Designing a scalable architecture and optimizing database queries are crucial to managing server load and maintaining performance.

3. Content Creation: A user-friendly interface for content creators to design quizzes with various question types (e.g., multiple choice, fill-in-the-blanks) and specific timestamps can be complex. Ensuring flexibility and ease of use without overwhelming the content creators is a challenge that requires thoughtful interface design and backend support.

4. Integration of Payment Gateway: Adding a payment gateway introduces challenges related to security and compliance. We need to ensure that the platform securely handles user payments, follows data privacy regulations, and provides a smooth transaction process without compromising user experience.

5. Data Privacy and Security: Given the sensitive nature of educational data, implementing robust security measures to protect user information and payment details is paramount. This includes encrypting data, securing communications, and ensuring compliance with data protection regulations.

Addressing these challenges is key to the successful implementation and operation of the platform. A thorough approach to architecture design, security protocols, and user experience considerations will be critical in overcoming these obstacles.

V. FUTURE PROSPECTS

The suggested gamified e-learning platform is a viable solution to the problems with online learning, especially with regard to student distraction and involvement. However, more research is needed in a few crucial areas to guarantee its long-term effectiveness and widespread adoption [21].

1. Integration with Educational Technologies:

- **a. Adaptive Learning Systems:** Future iterations of the platform could explore integrating with adaptive learning systems [22]. This would allow for personalized learning paths, with gamified elements adapting to individual student needs and progress.
- **b. Mobile Learning:** Gamified mobile applications could be developed based on the same idea to maximize the accessibility for students to learn, further promoting engagement and knowledge retention [23].

2. Technological Advancements:

- **a. Integration of Artificial Intelligence (AI):** AI-powered tools that evaluate student performance and offer adaptive feedback have the potential to personalise the educational experience [24]. AI could also reduce the workload for educators by automating some content creation chores.

3. Improving Accessibility:

- **a. Learner Diversity:** The platform should cater to diverse learning styles and abilities. This could include offering alternative quiz formats (e.g., audio-based) or incorporating accessibility features for learners with disabilities [25].

Gamified e-learning platforms, such as the one put forth, have the potential to completely transform online learning by addressing these future opportunities and staying adaptable to changing technological

advancements and pedagogical demands. They can design stimulating and productive learning environments that enable students to take command of their education and realise their greatest potential.

VI. CONCLUSION

The proposed gamified learning platform offers an innovative solution to the challenges of learner engagement and content interactivity in online education. By integrating features such as quizzes, daily streaks, points, and leaderboards, the platform aims to create a dynamic and immersive learning environment that encourages consistent participation and improves retention. For content creators, the platform simplifies course creation through an intuitive interface that allows video uploads, timestamped quiz integration, and seamless content management. With AWS S3 ensuring reliable video storage and Next.js and MongoDB enabling efficient system performance, the platform is designed for scalability and responsiveness, meeting the needs of a growing user base.

While the platform is still in the proposal stage, its anticipated outcomes, informed by prior research and existing gamified systems, highlight its potential to improve course completion rates, foster community engagement, and enhance knowledge retention. The dual-platform approach provides tailored solutions for both learners and creators, ensuring an optimised experience for all users. Moving forward, the platform's success will depend on its ability to address challenges such as user onboarding, content quality, and scalability. By continuously refining its features and incorporating advanced tools like adaptive learning and analytics, the platform has the potential to transform the e-learning landscape and set a new benchmark for interactive and gamified education.

Appendix A: Key Metrics Definitions

LLM (Learner Level Metric)
A composite metric that evaluates the learner's overall progress by incorporating various performance indicators such as quiz results, engagement levels, and consistency.

RPS (Recent Performance Score)
Reflects the learner's recent performance in assessments, emphasizing improvement or decline over a specific period.

DS (Difficulty Score)
Quantifies the complexity level of quizzes or tasks to ensure adaptive learning by matching content difficulty to the learner’s ability.

QPS (Quiz Performance Score)
A score calculated based on quiz accuracy and completion time, contributing to the Learner Level Metric (LLM).

ES (Engagement Score)
Measures the learner's involvement in the platform by tracking activities like course access, quiz participation, and login frequency.

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