WEB ENGINEERING END SEMESTER PROJECT

NATIONAL OPEN-COURSEWARE

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1 Introduction

The public GitHub repository for our project can be found using this link: `https://github.com/tayyibgondal/National_Open_Courseware.git`. The students who worked on this End Semester Project are Tayyib Gondal and Muhammad Faras Siddiqui.

2 Problem Statement

Education is a crucial foundation for personal and societal growth, and yet in Pakistan, there exists a significant barrier to accessing comprehensive and diverse educational resources. The lack of easily accessible and centralized online platforms specifically designed for Pakistani students and individuals hinders the free and open sharing of knowledge. Existing educational materials, such as university slides, textbooks, and research papers, are scattered across various sources, making it challenging for students to find relevant and high-quality resources. This fragmented landscape limits the opportunities for learning and intellectual development, hindering the potential of individuals and the progress of the nation.

Moreover, the absence of an interactive learning environment undermines the collaborative spirit necessary for fostering knowledge-sharing and collective growth. Students often face isolation in their educational pursuits, lacking platforms where they can engage with peers, participate in discussions, and collaborate on projects. This lack of community and interaction inhibits the development of critical thinking skills, problem-solving abilities, and the exploration of diverse perspectives.

Furthermore, the language barrier poses a significant challenge. Many educational resources are predominantly available in languages other than Urdu, the native language of Pakistan. This language divide restricts access to valuable materials, limiting the learning opportunities for those who are more comfortable or proficient in Urdu.

As an additional challenge, sustainability and funding remain crucial considerations. Developing and maintaining a high-quality educational platform requires continuous effort and resources. Without a sustainable funding model, the long-term viability and growth of such a platform become uncertain, jeopardizing its potential impact on education and hindering its ability to serve the needs of Pakistani students effectively.

3 Project Details

The technology stack used for this project is MERN (MongoDB, Express.js, React.js, Node.js). This technology was chosen as both students working on this project had little to no experience working with MERN stack before and we used this project as a chance to gain on hands experience of MERN stack.

3.1 Stakeholders

The stakeholders and users of this web-based solution include:

- Underprivileged communities in Pakistan who cannot afford to attend top universities but have a desire to learn new skills.
- University students in Pakistan who are enrolled in university but cannot afford to take additional courses from other departments.
- Faculty members and professors in Pakistan who may be interested in contributing to the platform by uploading course content.

- Potential employers in Pakistan who may benefit from a more educated and skilled workforce.
- The government of Pakistan, which may be interested in supporting initiatives that promote education and skill development.
- Donors that spend money on the betterment of education in Pakistan.

3.2 Technology Stack Selection: Why MERN?

The decision to employ the MERN (MongoDB, Express.js, React.js, Node.js) stack for our Open Course Ware (OCW) application was driven by several key considerations:

1. Full-Stack JavaScript: The MERN stack provides a full-stack JavaScript solution, enabling consistency and coherence across both frontend and backend development. This alignment simplifies the development process, promotes code reuse, and facilitates collaboration among team members.
2. Flexibility and Scalability: MongoDB, a NoSQL database in the MERN stack, offers flexibility in handling diverse data common in OCW applications. Its scalability aligns with the potential growth of our platform, accommodating varying data demands efficiently.
3. Rapid Development with React.js: React.js, a JavaScript library for building user interfaces, expedites frontend development. Its component-based architecture encourages modular design, allowing code reusability and maintainability.
4. Efficient Backend with Node.js: Node.js, as the backend runtime, supports the handling of concurrent requests efficiently. Its event-driven architecture ensures optimal performance, aligning with the need for a responsive backend capable of managing multiple user interactions seamlessly.
5. Established Ecosystem and Community Support: The MERN stack benefits from a robust ecosystem and an active developer community. This ensures access to a wealth of resources, third-party libraries, and community-driven support. Leveraging this ecosystem accelerates development, enhances problem-solving, and keeps our technology stack aligned with industry best practices.

In summary, the MERN stack was chosen for its ability to provide a consistent, flexible, and scalable solution for our OCW application. The alignment of technologies within the stack facilitates rapid development, promotes maintainability, and ensures responsiveness across both frontend and backend components.

3.3 Project Functionality - How we solved the problem?

To address these challenges, we have developed an open courseware website specifically tailored to the Pakistani context. Our website harnesses the functionality of the MERN (MongoDB, Express.js, React.js, Node.js) stack, providing a scalable platform that is apt to the unique needs of Pakistani students and learners.

The main features of our platform aim to improve the educational landscape in Pakistan:

1. Uploading and Downloading of Educational Resources: Our platform allows users, including students, educators, and researchers, to easily upload and share educational materials. University slides, textbooks, research papers, and other relevant resources can be accessed and downloaded by anyone, free of charge. By facilitating the open sharing of knowledge, we created a collective pool of resources that benefits learners across the country.

2. AI Chatbot: Our platform integrates an AI-powered chatbot that utilizes advanced natural language processing and machine learning techniques. Users can upload files related to their studies, and the chatbot thoroughly analyses and understands the content. It then provides intelligent and contextually relevant answers to users' prompts and inquiries, acting as a virtual study companion and enhancing the learning experience.

3. Subject/Topic-based Chat Rooms: Recognizing the significance of collaboration and community in the learning process, we have incorporated subject/topic-based chat rooms within our platform. Students can join specific rooms based on their subjects or topics of interest, enabling them to engage in discussions, share insights, seek clarification, and collaborate on assignments or projects. This interactive space fosters a sense of belonging, peer learning, and intellectual growth.

4. Urdu Translation Option: To overcome the language barrier and ensure that educational resources are accessible to a broader audience, our platform offers an intuitive Urdu translation option. Users can choose to translate resources into Urdu, enabling those who are more comfortable or proficient in the language to access and benefit from the materials.

5. Enhanced Communication and Support We have implemented a contact and donation form system that not only allows users to submit their queries and contributions but also ensures prompt communication. Upon submission, users receive a confirmation email, providing them with the reassurance that their message has been received and will be addressed promptly.

6. Accessible Career Paths To facilitate users' professional growth and development, we have made career paths readily available on our website. Users can easily download comprehensive career guides that provide valuable insights and guidance on various career options. By offering this resource, we aim to empower our users with the information needed to make informed decisions about their future.

7. Engaging Chatroom Experience In order to engage our users, we have gamified the chatroom functionality on our website. By incorporating interactive elements and features, we have created an immersive environment that encourages active participation and enhances user experience. This innovative approach not only creates a sense of enjoyment but also ensures that users remain intrigued and invested in the conversations taking place.

8. Frequently Asked Questions (FAQs) Support We understand the importance of addressing common queries and concerns effectively. To streamline this process, we have implemented a FAQ system. Users now have the ability to ask their frequently asked questions directly through our platform. Our administrators promptly respond to these inquiries, ensuring that users receive accurate and helpful information in a timely manner.

9. Functionality Segregation and Access Control We have implemented a robust functionality segregation system that distinguishes between admin and non-admin users.

10. Secure Endpoints At the core of our website, we prioritize security. To safeguard sensitive information and protect user privacy, we have implemented secure endpoints.

3.4 Incorporating Microservices Architecture

Our Project Architecture: While improving the functionality of our application, we decided to incorporate a chatroom feature. Originally, we intended to integrate the chatroom into our existing backend. However, due to the real-time nature of the chatroom, we recognized the potential for increased load, which could adversely impact the overall performance of the system.

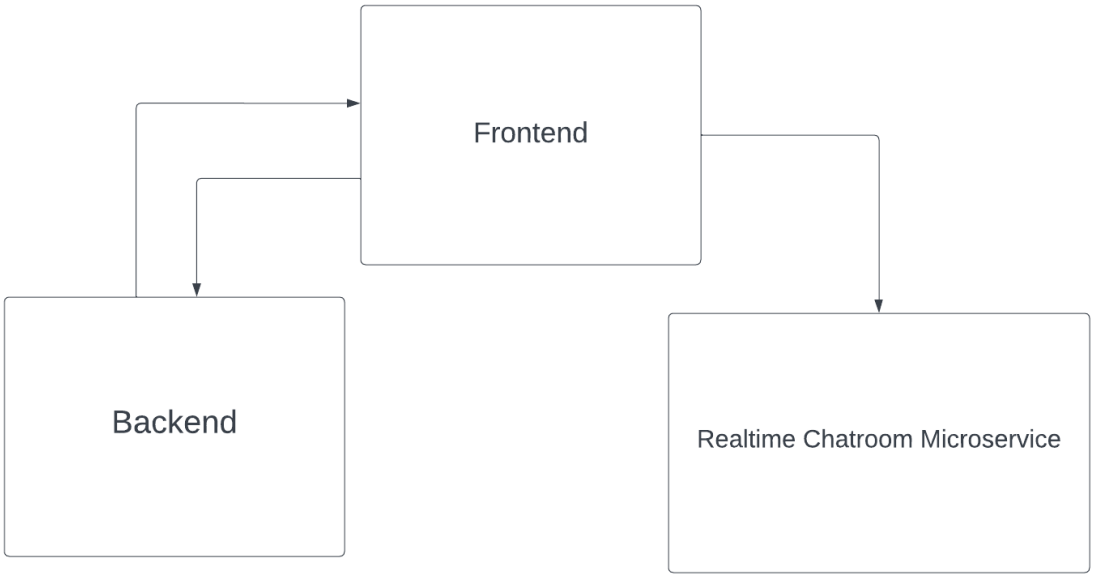

Figure 1: Architecture diagram.

To address this concern and ensure optimal performance, we made the decision to separate the chatroom functionality from the main backend. We adopted a microservice architecture approach, creating a dedicated microservice specifically for the chatroom. This microservice allows us to handle the real-time functionality efficiently and independently, preventing any unnecessary burden on the rest of the program.

By implementing the chatroom as a separate microservice, we maintained the integrity and scalability of our application, which would ensure communication and responsiveness within the chatroom while preserving the overall performance and stability of the system.

4 Conflicting requirements

Website Design and Gamification: In designing our educational website, we adopted a deliberate approach focused on simplicity, recognizing the importance of creating a user-friendly online encyclopedia. Understanding the unique nature of our platform, we avoided excessive gamification elements that could potentially distract from the educational content.

However, to balance between a simplified user interface (UI) and an engaging experience, we identified an opportunity to enhance the gamification aspect within the chatrooms microservice. By leveraging this microservice, we were able to introduce gamification elements specifically tailored to the chatroom user interface, elevating its visual appeal and interactivity.

This decision allowed us to address the conflicting requirement of maintaining a simplified overall UI while ensuring a visually appealing and captivating experience within the chatrooms. By gamifying the chatrooms microservice, we provide an additional layer of enjoyment and engagement, without compromising the core educational focus of the website.

The result is an educational website that retains its clean and straightforward design, akin to an online encyclopedia, while incorporating an enticing and visually appealing gamified UI within the chatrooms microservice. This integration enhances the overall user experience, fostering a sense of enjoyment and interactivity while staying true to our primary goal of providing educational content.

5 Challenges Faced

While developing our Open Course Ware (OCW) application, we encountered several challenges that influenced our development process. These challenges, while demanding, presented valuable learning opportunities and shaped our problem-solving strategies. The following are key challenges faced during the project:

1. Data Modeling Complexity: Managing various types of content, user interactions, and relationships between entities required a careful and flexible approach.

2. Translation Integration: Integrating translation services for multilingual support in our OCW content proved challenging due to the dynamic nature of the content and the need for accurate translations. This is because a lot of our users might not be able to understand English, and we needed to convert to Urdu.

3. Integration of ChatPDF: Incorporating ChatPDF for our AI tutor component was challenging as we had to learn how to use and incorporate a third-party service into your project.

4. Building Chatroom from Scratch: Developing a custom chatroom solution from scratch demanded a lot of time, and this probably is the most complex part of our website. We implemented a robust chatroom system, utilizing technologies like Socket.io for real-time communication. Since the chatroom has to be real time and robust, we made a separate microservice for it as well, keeping in view the fact that we might be deploying this in the future.

5. Frontend and Backend Integration: Integrating the frontend and backend components to ensure a cohesive user experience and efficient data flow presented integration challenges.

6. Security Considerations: Ensuring the security of user data and preventing unauthorized access to course materials required comprehensive security measures. Solution: We implemented authentication and authorization mechanisms.

6 Conclusion

In conclusion, our open courseware website specifically designed for Pakistan aims to address the critical challenges faced by students and individuals in accessing educational resources. By leveraging the MERN stack, we have created a comprehensive platform that facilitates the free sharing of university slides, textbooks, research papers, and other materials. Our website not only provides a centralized repository for these resources but also fosters a collaborative learning environment.

With the integration of an AI chatbot, students can receive personalized assistance in studying uploaded files and obtain intelligent responses to their queries. This AI-powered feature enhances the learning experience and promotes efficient knowledge acquisition. Additionally, our platform offers subject/topic-based chat rooms, allowing students to engage in discussions with peers who share similar academic interests. This interactive space encourages collaboration, critical thinking, and the exchange of diverse perspectives.

Recognizing the language diversity in Pakistan, we have incorporated an Urdu translation option. By providing this feature, we aim to break down language barriers and make educational resources more accessible to a wider audience. Furthermore, we have implemented a secure donation gateway to ensure the sustainable development and maintenance of the platform. Through the support of users and donors, we can continue expanding the platform's offerings and impact on education in Pakistan.

By addressing the challenges of fragmented resources, limited collaboration opportunities, language barriers, and funding constraints, our open courseware website strives to empower students

and learners across Pakistan. Our vision is to create an inclusive and equitable educational ecosystem where individuals can freely access educational materials, engage in meaningful discussions, receive personalized support, and contribute to the growth and development of the platform.

Through the collective efforts of students, educators, and the broader community, we can build a brighter future for education in Pakistan, nurturing a generation of knowledgeable, creative, and empowered individuals who can drive positive change in society.