Adaptive Learner Centric LMS: Enhanced Student Engagement and Personalized Learning Experiences

24-25J-112

Project Proposal Report

Monali G M N – IT21360428

B.Sc. (Hons) Degree in Information Technology Specialized in Software Engineering

Department of Computer Science and Software Engineering
Sri Lanka Institute of Information Technology Sri Lanka

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Declaration

We declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Monali G.M.N.	IT21360428	

The supervisor/s should certify the proposal report with the following declaration.

The above candidates are out research for the undergraduate Dissertation under my supervision.

Signature of the Co-Supervisor: Date:

Ms. Thilini Jayalath

23/8/24

Abstract

The Adaptive Learner-Centric Learning Management System (LMS) aims to transform personalized education by tailoring quizzes and assignments to individual student performance in real time. Using advanced technologies like large language models (LLMs) and seamless LMS integration, the system provides personalized learning paths, adaptable assessments, and instant, customized feedback. This approach is designed to enhance educational outcomes by continuously monitoring progress and adapting to each learner's unique needs, supporting diverse learning styles. This paper details the methodology, system design, and potential impact of this innovative adaptive learning solution.

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Abbreviation	Descriptions
LMS	Learning Management System
NLP	Natural Language Processing
LLM	Large Language Models

1. Introduction

In recent years, adaptive learning has become an important area of study in education technology. This project focuses on developing a component of an Adaptive Learner-Centric Learning Management System (LMS) that creates personalized quizzes and assessments. The aim is to enhance the learning experience by adapting to each student's individual needs.

1.1. Background & Literature survey

Adaptive learning systems have significantly advanced, with platforms such as Coursera [1] leading the way in personalized education. These platforms aim to tailor learning experiences to each student's needs. However, achieving real-time adaptation and providing personalized assessments remain challenging [2].

	Theme	Rating		
		Agree	***Somewhat agree***	***Disagree***
1	Content creation and sharing	76.2%	19.0%	4.8%
2	Communicative feature design	85.7%	9.5%	4.8%
3	Teacher-centred structure	81.0%	14.3%	4.8%
4	Learner disengagement	71.4%	19.0%	9.5%
5	Inflexible assessment	85.7%	9.5%	4.8%

Figure 1 LMS Failure Aspects Rating

Early methods for quiz generation were primarily rule-based. For example, Driouech et al. (2008) developed a quiz generator for mathematics integrated within a CMS, which allowed some level of automation but was limited by its static nature [3]. Kang (2024) introduced a "Personalized Quiz Maker" for the Alby LMS, which added some customization features but still struggled with real-time adaptability [4].

Recent advancements in natural language processing (NLP) have improved quiz generation techniques. Ledi (2022) developed an automatic quiz generation system using NLP, which marked progress over previous methods but still faced limitations in dynamic adaptability [5]. Revisely's online quiz generator offers ease of use but does not address the need for personalized, adaptive assessments [6].

Studies such as those by Alhazmi et al. (2021) have identified the need for more adaptive LMS solutions that can respond to individual learning needs effectively [2]. Research by Kardan and Conati (2015) demonstrated the benefits of intelligent tutoring systems that adapt to student behavior, highlighting the potential of real-time data in enhancing personalized learning [7]. Additionally, Shute and Spector (2008) explored stealth assessments, which integrate adaptive quizzes into the learning process, allowing for continuous assessment without interrupting the student's experience [8].

Our approach builds on these advancements by integrating real-time data analysis with adaptive quiz generation. This aims to offer a more dynamic and responsive learning experience compared to existing systems.

2.1. Research Gap

Despite the progress in adaptive learning systems and quiz generation technologies, several gaps remain. Existing systems often lack real-time adaptability, which is crucial for personalized learning. Many traditional quiz generation methods are either rule-based or static, failing to adjust dynamically to individual student performance.

For example, while Driouech et al. (2008) created a quiz generator integrated with a CMS, it primarily relied on preset rules rather than real-time data [3]. Kang's (2024) Personalized Quiz Maker, though innovative, still encounters limitations in adapting quizzes in response to ongoing student performance [4]. The automatic quiz generation system by Ledi (2022) marked a significant advancement by utilizing natural language processing, but it still struggles with dynamic adaptability [5].

The gap in current research is the integration of advanced adaptive techniques with real-time data to enhance personalization. Alhazmi et al. (2021) pointed out that many LMS solutions do not fully exploit the potential of adaptive learning technologies [2]. Additionally, while intelligent tutoring systems, as discussed by Kardan and Conati (2015), have made strides in adaptive support, their focus has often been on broader instructional methods rather than specific quiz generation [7].

The need for a system that combines real-time performance tracking with adaptive quiz generation is evident. Research by Shute and Spector (2008) on stealth assessments shows the promise of integrating assessment into the learning process but does not address the need for adaptive quizzes that continuously evolve with the learner's progress [8].

Our research aims to address these gaps by developing an adaptive quiz generation system that leverages real-time data to provide personalized and dynamic assessments. This approach seeks to enhance the effectiveness of personalized learning by ensuring that quizzes adapt to the changing needs of students as they progress through their learning journey.

Table 1 Research Comparison

Feature	Quiz Generator Extension inside CMS [3]	Alby Learning Management System [4]	Automatic Quiz Generation System (NLP) [5]	Revisely Quiz Generator [6]	Our system
Real-Time Adaptability	×	✓	×	×	✓
Flexible Assessments	✓	✓	✓	×	✓
Progress Tracking	×	✓	×	×	✓
Use of Large Language Models	×	×	✓	×	✓
Integration with LMS	✓	✓	✓	×	✓
Dynamic Personalization	×	✓	✓	×	✓
Real-Time Performance Tracking	×	×	×	×	✓

3.1. Research Problem

- **Real-Time Adaptability**
  Existing systems often cannot adjust quizzes based on real-time performance data [4] [3]. This means that quizzes might not align with a learner's immediate needs.

- **Dynamic Personalization**
  While some systems offer personalized assessments, they may not adapt dynamically as learners progress [5]. This limits the system's ability to cater to evolving learning needs.

- **Integration with LMS**
  Many quiz generators do not integrate seamlessly with LMS platforms [6]. This can lead to fragmented user experiences and data management issues.

- **Real-Time Performance Tracking**
  Current approaches often fall short in tracking and responding to student performance in real-time, which is crucial for providing timely feedback.

Our research aims to overcome these issues by creating a system that integrates well with LMS platforms, adapts quiz content in real-time, and offers personalized assessments to improve the learning experience.

2. Objectives

2.1. Main Objectives

The primary aim of this study is to develop an Adaptive Learner-Centric Learning Management System (LMS) that enhances personalized learning through advanced quiz and assessment mechanisms. This system is designed to dynamically adjust to individual student needs by integrating real-time adaptability, flexible assessments, and effective progress tracking. Our goal is to improve the overall learning experience by providing tailored quizzes that respond to students' performance and learning styles, seamlessly integrating with existing LMS platforms.

2.2. Specific Objectives

Develop Real-Time Adaptive Quizzes: Create a system that adjusts quiz difficulty and content based on real-time student performance data to ensure a personalized learning experience.

Implement Flexible Assessment Features: Design and implement assessments that can be customized according to individual learning needs and preferences.

Enhance Progress Tracking: Develop tools to track student progress in real-time, providing detailed feedback and insights to both students and instructors.

Integrate with LMS Platforms: Ensure seamless integration of the quiz and assessment system with popular LMS platforms to facilitate smooth operation and data sharing.

Provide Dynamic Personalization: Implement algorithms that offer personalized quiz generation and learning paths based on student performance and engagement levels.

3. Methodology

3.1. Requirement Gathering and Analysis

The initial phase involves collecting and analyzing requirements to define the scope and objectives of the project.

- Stakeholder Interviews - Conduct interviews with educators, students, and LMS administrators to understand their needs and expectations.
- Literature Review - Analyze existing research and technologies related to adaptive learning systems, quiz generation, and LMS integration.

3.2. Feasibility Study

3.2.1. Schedule Feasibility

- Assess the project timeline and determine if the proposed deadlines are achievable. Develop a detailed project schedule with milestones using a Gantt chart.

3.2.2. Technical Feasibility

- Evaluate the technical requirements and ensure that the necessary tools, technologies, and algorithms are available and compatible. This includes the MERN stack and adaptive algorithms.

3.2.3. Operational Feasibility

- Analyze the operational aspects to ensure that the system can be effectively implemented and used within the existing LMS infrastructure.

3.2.4. Financial Feasibility

- Estimate the project costs and budget, ensuring that the financial resources are sufficient for development, testing, and deployment.

3.3. System Development and Implementation

3.3.1. Design and Development

System Design

This phase involves creating a detailed plan for how the system will function. It includes outlining the system's architecture, defining how different components will interact, and designing the user interface.

Implementation

Once the design is ready, the system will be built using the MERN stack (MongoDB, Express.js, React, and Node.js). This involves coding the front-end, back-end, database, and the algorithms that will personalize quizzes and assessments based on student performance.

Adaptive Algorithms

The system's core feature is its ability to adjust quizzes in real-time according to how students perform. Algorithms will be developed to analyze quiz results and adapt future quizzes to meet each student's individual needs.

3.3.2. Integration

LMS Integration

The system will be designed to work seamlessly with existing Learning Management Systems (LMS). This means that the system will be able to exchange data with the LMS, allowing features like adaptive quizzes and progress tracking to be accessed directly within the LMS.

Data Sharing and Functionality

Integration also ensures that all system features, such as quizzes and feedback, are accessible within the LMS. This is done by connecting the system to the LMS through APIs, making it easy for users to access all functionalities in one place.

3.4.Testing and Validation

- **Unit Testing**
  Test individual components for functionality and performance.
- **Integration Testing**
  Verify that all system components work together as intended.
- **User Acceptance Testing**
  Conduct testing with actual users to gather feedback and ensure the system meets their needs.

3.5. Deployment and Maintenance

Deployment

The deployment phase involves introducing the system into the actual environment where it will be used. This includes setting up the software on servers, ensuring all components work together smoothly, and making sure the system is accessible to users. The goal is to make the transition from development to everyday use as seamless as possible, minimizing any disruption to existing processes.

Maintenance

After deployment, maintenance ensures the system continues to run efficiently. This includes fixing any issues that arise, updating the software to improve performance or security, and adapting the system to meet new user needs or requirements. Regular maintenance keeps the system up-to-date and reliable for long-term use.

3.6.Tools, Technologies and Algorithms

- **MERN Stack**

  MongoDB- For storing quiz data and student information.

  Express.js- For handling server-side logic.

  React- For building the user interface.

  Node.js- For running server-side code.

- **Large Language Models (LLMs)**

  For generating and customizing quiz questions based on individual student performance.

- **Data Pre-processing**

  Cleaning and preparing data to ensure it is accurate and usable for generating quizzes and assessments.

- **Real-Time Adaptation Technologies**

  To adjust quiz difficulty and content based on student performance in real-time.

- **Progress Tracking Tools**

  For monitoring and visualizing student progress and performance.

- **Git**

  Version control system for tracking changes and collaboration.

3.7.System Overview Diagram

The aim of this project is to develop an Adaptive LMS that enhances student engagement by providing personalized learning experiences tailored to individual needs and performance levels. Key features include adaptive study tools, an AI-powered assistant for self-directed learning, interactive mind maps, and personalized quizzes.

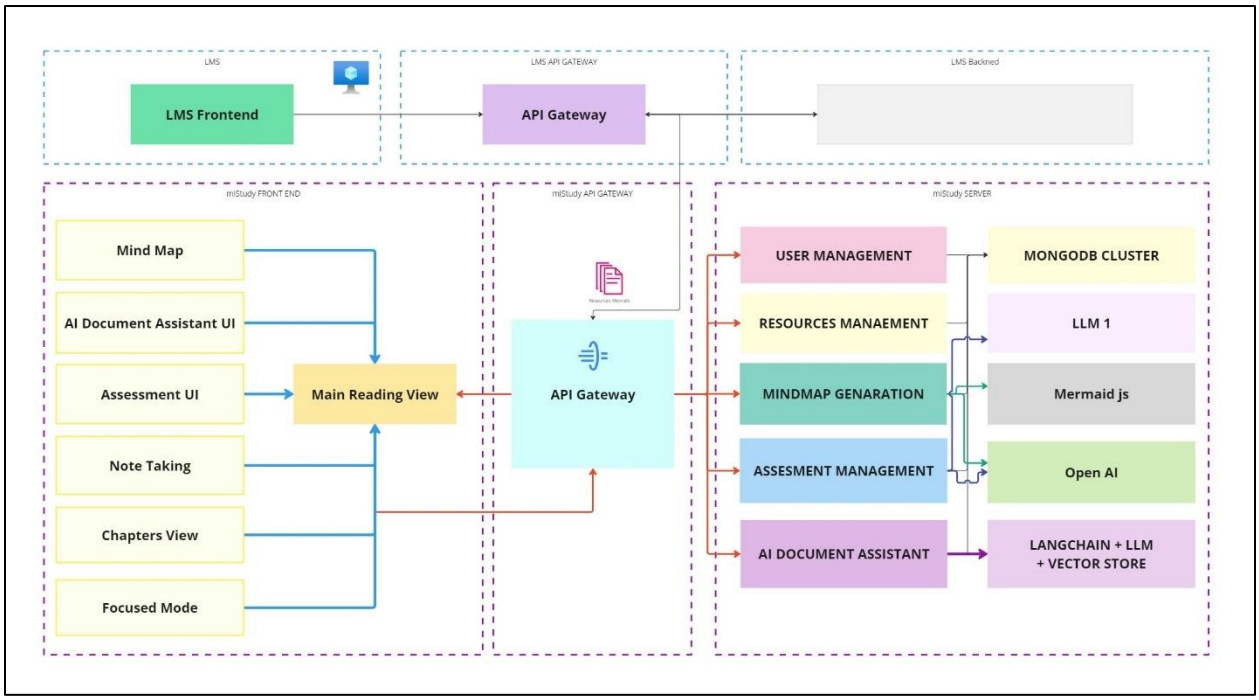

Figure 2 System Overview Diagram

3.8. System Diagram of the Component

The Adaptive Quizzes and Assessments component is designed to dynamically adjust to each student's learning needs and performance levels.

- **Dynamic Quiz Generation**

  Based on students' performance in initial quizzes, the system generates tailored quizzes that match their learning levels.

- **Real-Time Adaptability**

  The quizzes adapt in real-time to students' responses, adjusting difficulty and content to better align with their evolving understanding.

- **Personalized Feedback**

  After each quiz, students receive specific feedback that highlights strengths and areas for improvement, guiding their next steps in learning.

- **Progress Tracking & Support System**

  The system monitors and tracks student progress over time, providing insights to both students and instructors.

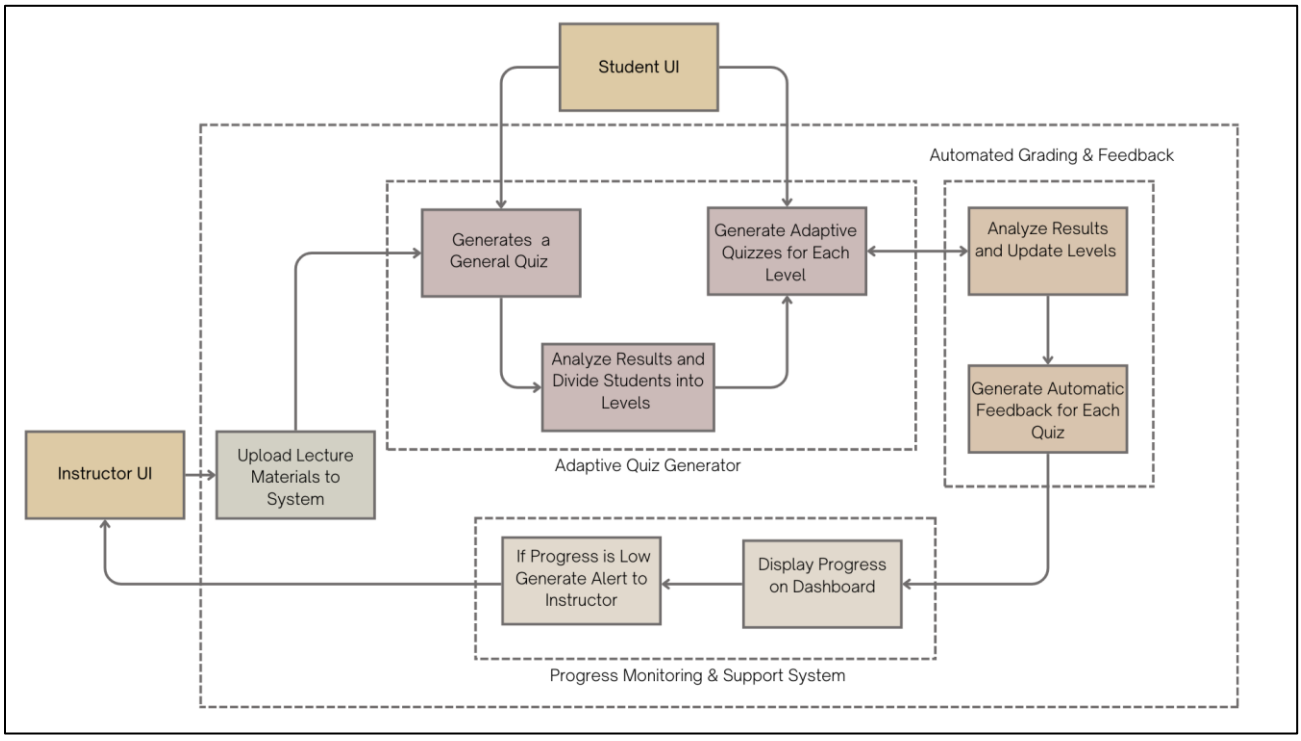

Figure 3 System Diagram of the Component

- The process begins with the instructor uploading lecture materials to the system.
- The system automatically generates a general quiz based on the uploaded materials.
- All students take this initial general quiz.
- The system analyzes the quiz results and categorizes students into different levels based on their performance.
- The system then creates level-specific quizzes tailored to each group of students.
- Students complete these personalized quizzes.
- The system reassesses student performance and adjusts their levels accordingly.
- The system provides automatic feedback for each quiz.
- Student progress is displayed on a dashboard for easy tracking.
- If a student's progress is low, the system alerts the instructor.
- Based on the overall progress and results, the system assists in preparing summative assignments.

3.9. Gantt Chart

No	Assessment / Milestione	2024- 2025													
		April	May	June	July	August	September	October	November	December	January	February	March	April	May
1	Research group formation														
2	Supervisor selection														
3	Brainstorming workshop 1														
4	Selection of research topic														
5	Co-supervisor selection														
6	Brainstorming workshop 2														
7	Feasibility and background study														
8	Topic registration from submission														
9	In-depth feasibility and background study 1														
10	External supervisor selection														
11	Topic assessment form submission														
12	Topic assessment from evaluation														
13	In-depth feasibility and background study 2														
15	Proposal presentation														
16	Individual proposal report submission														
17	Implementation of research work(upto 50%)														
18	Progress presentation 1														
19	Prepare and submit research paper														
20	Implementation of research work(upto 90%)														
21	Progress presentation 2														
22	Integration of the research work														
23	Project completion														
24	System testing														
25	Website and final report preparation														
26	Final presentation														
27	Final report submission														

Figure 4 Gantt Chart

3.10. Work Break Down Structure

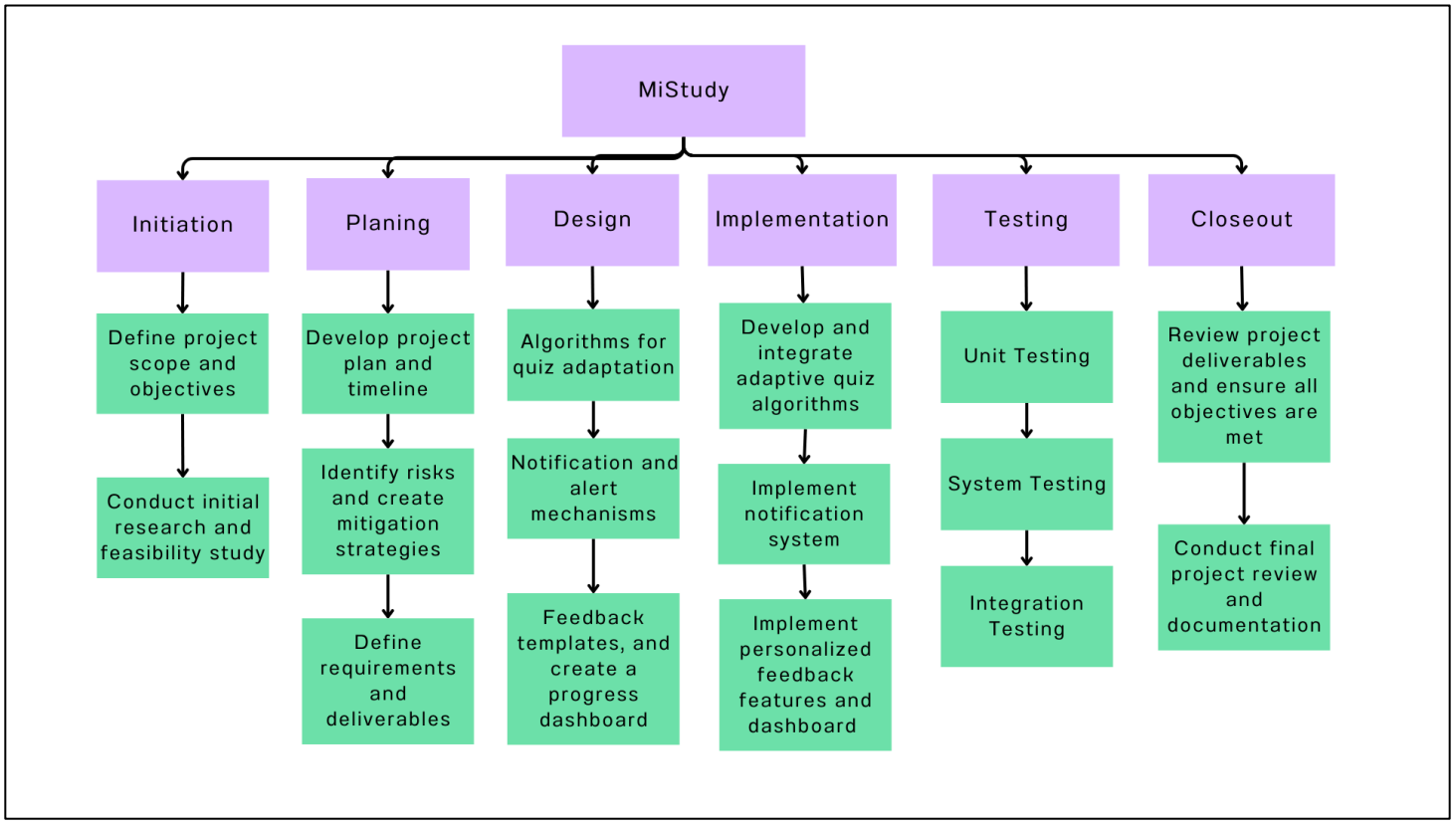

Figure 5 Work Break Down Structure

4. Project requirements

4.1. Functional Requirements

- **User Authentication and Authorization**
  The system must provide secure login and access control, ensuring that only authorized users can access specific features.

- **Quiz Generation**
  The system should generate quizzes based on the lecture materials provided by instructors. Quizzes must be dynamically personalized according to the individual performance levels of students.

- **Real-Time Adaptability**
  The system must adapt quizzes in real-time based on the student's ongoing performance, providing appropriate challenges and support.

- **Progress Tracking**
  The system should track students' progress over time, allowing both students and instructors to monitor learning outcomes.

- **Feedback Mechanism**
  The system should provide immediate and personalized feedback after each quiz, helping students understand their strengths and areas for improvement.

- **LMS Integration**
  The system must seamlessly integrate with existing LMS platforms, allowing easy access and data sharing.

4.2. Non-Functional Requirements

- **Performance**

  The system must handle multiple users simultaneously without degradation in performance. Quizzes should be generated and delivered to users with minimal latency.

- **Scalability**

  The system should be able to scale to accommodate an increasing number of users and quizzes.

- **Usability**

  The system must have a user-friendly interface that is intuitive and accessible for all users, including students and instructors.

- **Security**

  The system must ensure data security and privacy, protecting user information and quiz data from unauthorized access.

- **Reliability**

  The system should be reliable, with minimal downtime and robust error-handling mechanisms.

- **Maintainability**

  The system should be designed for easy maintenance, allowing updates and modifications to be made with minimal disruption.

4.3. Expected test cases

- **Quiz Generation Tests**

  Verify that quizzes are correctly generated based on the provided lecture materials.

  Test the dynamic adaptation of quizzes according to different performance levels.

- **Real-Time Adaptability Tests**

  Ensure that the system correctly adjusts the difficulty of quizzes in real-time based on student performance.

  Test the system's ability to provide immediate feedback.

- **Progress Tracking Tests**

  Validate that student progress is accurately tracked and reported.

  Test the integration of progress tracking with the LMS.

- **Performance Tests**

  Test the system under various loads to ensure it meets performance requirements.

  Conduct stress tests to evaluate the system’s scalability.

- **Usability Tests**

  Evaluate the user interface for ease of use and accessibility.

  Gather feedback from actual users to assess the overall user experience.

- **Security Tests**

  Test the system for vulnerabilities, including data breaches and unauthorized access.

  Validate the effectiveness of encryption and other security measures.

5. Commercialisation

The proposed system will be commercialized as a plugin for existing Learning Management Systems (LMS).

The commercialization strategy involves the following key components:

1. Plugin Integration

- The system will be offered as a plugin that integrates seamlessly with existing LMS platforms. This integration will be achieved through API endpoints, allowing smooth communication between the plugin and the LMS.

2. Document Handling

- Users will be able to upload various document formats such as PDFs, Word documents, and PowerPoint presentations.
- The system will automatically extract relevant data from these documents, making it available for quiz generation and other functionalities.

3. Data Management

- Extracted data will be stored securely within the system. This ensures that all information needed for quiz creation and student progress tracking is readily available and well-organized.

4. Learner-Centric Interface

- The plugin will provide a learner-centric interface within the existing LMS, offering an intuitive and user-friendly experience. This interface will facilitate easy access to quizzes, progress tracking, and feedback.

5. Online Platform

- An online platform will be provided where students can register and use the system. This platform will allow them to upload their documents, access personalized quizzes, and track their learning progress.

6. References

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7. Appendices

7.1. Signed Document

DECLARATION

We declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidates are out research for the undergraduate Dissertation under my supervision.

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