

**Mutah University, Karak Jordan**

**Faculty of Information Technology**

**Quiz AI**

**A project submitted**

**in partial fulfillment of the requirements for the**

**B.Sc. Degree in Information Technology**

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# CERTIFICATE

It is hereby certified that the project titled ***Quiz AI***, submitted by undersigned, in partial fulfillment of the award of the degree of “Bachelor in Software Engineering” embodies original work done by them under my supervision.

All the analysis, design and system development have been accomplished by the undersigned. Moreover, this project has not been submitted to any other college or university.

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# ABSTRACT

**Problem Statement:** This software is an AI-powered educational tool designed to transform lecture audio into tailored exams, enhancing students’ comprehension and retention. Users can record lectures directly or upload existing audio files, which are then processed using advanced speech recognition and natural language processing (NLP) techniques. The system identifies key concepts, learning objectives, and contextual cues from the lecture, generating quizzes or exams with customizable difficulty levels and question types. The platform aims to bridge the gap between passive listening and active learning by converting unstructured lecture content into interactive, measurable assessments. By providing immediate feedback and promoting self-testing, it fosters deeper engagement, better knowledge retention, and improved academic performance.

**Proposed Solution:** The project involves developing a platform that converts lecture audio into automatically generated exams. Users can record lectures directly or upload audio files (MP3, MP4). The system applies speech recognition and NLP to extract key concepts and produce various question types, including multiple-choice, fill-in-the-blanks, true/false, and short answer. Users can save generated exams, track their progress, and engage in efficient revision for improved understanding of lecture material.

**Project Aim:** To enhance students’ comprehension and retention by transforming lecture audio into personalized exams, enabling active learning through immediate, targeted self-assessment and focused revision.

**Objectives:**

1. Support lecture audio recording and upload for automatic exam generation.
2. Extract key concepts from audio using speech recognition and NLP.
3. Generate diverse question types (multiple-choice, fill-in-the-blanks, true/false, short answer).
4. Allow users to save, organize, and manage generated exams in personal libraries.
5. Provide instant feedback and performance tracking to support adaptive learning.

**Expected Benefits:**

* Time-saving study sessions through automated quiz generation.
* Personalized learning by identifying weak areas and enabling repeated practice.
* Enhanced student engagement and knowledge retention through interactive assessments.

# ACKNOWLEDGEMENTS

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# ABBREVIATIONS

| **Abbreviation** | **Full Form** |
| --- | --- |
| AI | Artificial Intelligence |
| NLP | Natural Language Processing |
| PDF | Portable Document Format |
| MS | Microsoft |
| MP3 | MPEG Audio Layer III |
| MP4 | MPEG-4 Part 14 |
| UI | User Interface |
| UX | User Experience |
| LMS | Learning Management System |
| SQL | Structured Query Language |
| IDE | Integrated Development Environment |
| VRAM | Video Random Access Memory |
| SSD | Solid State Drive |
| UAT | User Acceptance Testing |
| JSON | JavaScript Object Notation |
| CPU | Central Processing Unit |
| RAM | Random Access Memory |
| LLM | Large Language Model |
| RAG | Retrieval-Augmented Generation |
| LoRA | Low-Rank Adaptation |
| ASR | Automatic Speech Recognition |
| OCR | Optical Character Recognition |
| GAN | Generative Adversarial Network |
| ML | Machine Learning |
| MCQ | Multiple Choice Question |
| DFD | Data Flow Diagram |
| UML | Unified Modeling Language |
| CRUD | Create, Read, Update, Delete |
| SSMS | SQL Server Management Studio |
| SQLi | SQL Injection |
| XSS | Cross-Site Scripting |

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# Introduction

This chapter provides an overview of the project, beginning with the challenges of transforming raw learning materials into meaningful assessments and summaries. It highlights the project’s goals, scope, and boundaries, alongside the software and hardware requirements necessary for both development and deployment. In addition, it outlines the limitations, expected outputs, project schedule, and associated risks. Together, these sections establish the foundation for understanding the motivation, objectives, and constraints guiding the design and implementation of the AI-powered quiz-generation system.

**1.1 Problem Statement: Successfully Translating Raw Learning Materials into Assessments and Summaries**

The digital learning age has brought the creation of course material in a wide variety of formats, from audio and video files to PDFs, Word documents, and presentations. Translating this blended content into official quizzes and brief summaries is normally time-consuming, hard work, and prone to human error.

A majority of the existing tools are limited to one file type or must be pre-prepared beforehand by hand, which is inefficient and discourages frequent use. This creates a problem for students as well as teachers in accessing interactive, stimulating, and useful study material, thus slowing down the learning process within hectic academic as well as training environments.

**1.2 Project Goal: From Formats to Knowledge — AI for Intelligent Learning Tools**

The aim of this project is to develop an AI-driven system capable of extracting important details from various content forms and converting it into quizzes and abstracts. Through the automation of assessment and summarization, the system will help students, instructors, and self-learners save valuable time, promote active learning, and enable the easy creation of good-quality learning materials.

In the long term, the solution is designed to reduce teaching load, improve knowledge retention, and promote more individualized, adaptive learning experiences across different learning environments.

**1.3 Project Scope: Establishing the Boundaries for AI-Powered Content Transformation**

This project is designed to develop an AI system that can accept various types of content like MP3, MP4, PDF, MS Word files, and PowerPoint presentations, and perform real-time audio and video content transcription. The system will automatically generate quizzes and summaries from the inputs via an easy, intuitive web-based interface.

**1.3.1 Key Features**

1. Content parsing and intelligent file format handling
2. Natural Language Processing (NLP) to pull out major points and ideas
3. Robot quiz creation from various question types (e.g., multiple choice, true/false, short answer)
4. Fast revision-boosted summary creation

**1.3.2 Within Scope**

1. File uploading in accepted formats
2. Real-time transcriptions
3. English-language content
4. Arabic-language content
5. Exporting quizzes in common formats
6. Interactive in-platform quiz-taking

**1.3.3 Out of Scope**

1. Third-party LMS integration (e.g., Blackboard, Moodle)
2. Non-English and non-Arabic language support
3. Mobile app development in this release

**1.4 Project Software and Hardware Requirements**

**1.4.1 Hardware Requirements**

Hardware requirements can be split into two parts: requirements for development and requirements for end-users.

**1.4.1.1 Requirements for Development**

**React**

* CPU: Intel Core i3
* RAM: 8 GB
* Storage: 10 GB (Kinsta, n.d.)

**C# Development using Visual Studio IDE**

* Processor: 1.8 GHz or faster processor (dual-core or better recommended)
* RAM: 2 GB (4 GB recommended, 2.5 GB minimum on a virtual machine)
* Hard Disk Space: Up to 130 GB depending on features installed; typical installations require 20–50 GB. SSD recommended
* Video Card: Supports minimum display resolution of 720p (1280 × 720); WXGA (1366 × 768) or higher recommended (Microsoft, 2025)

**TinyLlama**

* Normally requires a minimum of 16 GB VRAM. Utilizing QLoRA reduces requirements (InsightReactions, 2025).

| **Hardware Component** | **Minimum Requirement** | **Recommended** | **Notes** |
| --- | --- | --- | --- |
| GPU VRAM | 6 GB | 8 GB+ (e.g., RTX 3070, 4060 Ti, 3080) | Most critical factor. 6 GB is the absolute minimum. |
| System RAM | 16 GB | 32 GB | Needed for loading datasets and background processes |
| Storage | ~10 GB Free | 20–50 GB Free | Space for base model (~2.2 GB TinyLlama-1.1B), datasets, adapter weights. SSD recommended |

**Table 1.1 Hardware requirements for running TinyLlama locally (InsightReactions, 2025).**

**1.4.1.2 Hardware Requirements for End-Users**

1. CPU: 4 cores or more
2. System RAM: at least 16 GB
3. GPU: NVIDIA GPUs only, 12 GB VRAM or higher
4. Storage: 60 GB SSD (250 GB recommended for additional models)
5. Wired internet connectivity during setup; wired LAN afterwards (InsightReactions, 2025)

**1.4.2 Software Requirements**

**1.4.2.1 Requirements for Development**

1. React: Windows 10/11, Ubuntu 16, or macOS 10.10 (Kinsta, n.d.)
2. C# development using Visual Studio IDE: Windows 10/11 (Microsoft, 2025)
3. TinyLlama: Windows 10/11, Ubuntu 16, or macOS 10.10 (InsightReactions, 2025)

**1.4.2.2 Requirements for End-Users**

* Windows 10/11, Ubuntu 16, or macOS 10.10

**1.5 Project Limitations**

**1.5.1 Technical Limitations**

1. Uses an open-source model agent as a base. Internet connection required (ITU, 2025).

A graph of blue bars with numbers

AI-generated content may be incorrect.

**Figure 1.1: Global internet penetration in 2025, highlighting the 67.9% population with access (Source: ITU, 2025).**

1. There is no application version of Quiz AI, which means it may not be as attractive to most of the population (GSMA, 2025).

A graph of green rectangular bars

AI-generated content may be incorrect.

**Figure 1.2: Lack of a Quiz AI mobile app may limit user adoption, illustrated by global mobile app engagement trends (Source: GSMA, 2025).**

**1.5.2 Functional Limitations**

* Unsupported: Extracting audio from video not implemented.
* Workarounds: Use third-party APIs.

**1.5.3 Security Limitations**

* No login security measures or encryption for login database.

**1.5.4 Usability & Accessibility**

* Supported file formats: txt, pdf, pptx, docx, mp3, mp4.

**1.6 Project Expected Output**

**1.6.1 Functional Outputs**

1. Responsive web dashboard
2. Notifications for processing start and completion

**1.6.2 Non-Functional Outputs**

1. Fast output time
2. 4-chapter documentation in PDF
3. GitHub repository with source code

**1.7 Project Schedule**

The project schedule outlines the key milestones, activities, and deliverables required to complete the AI-powered quiz-generation website. It ensures each stage of the development process is completed on time, with clear dependencies between tasks.A chart with multiple colored bars

AI-generated content may be incorrect.

**Figure 1.3: Project schedule Gantt chart illustrating key milestones, activities, and deliverables for the AI-powered quiz-generation website (Source: Project Team, 2025).**

**1.8 Methodology Framework Diagram**

A methodology framework diagram is a visual representation that outlines the structured steps (the methodology) within a guiding structure (the framework) to carry out a process or research—often shown as boxes and arrows depicting stages and relationships (ResearchGate, 2008).



**Figure 1.4: Methodology Framework Diagram**

**1.8.1 Workflow Steps**

1. **Requirement Gathering:** Identify goals, define user roles, collect expectations.
2. **Data Collection:** Gather books, slides, notes, and other materials.
3. **Data Preparation:** Clean, organize, remove duplicates, structure topics.
4. **System Design:** Draw use case diagrams, DFDs, sequence diagrams.
5. **AI Model Development:** Build and train AI to generate quizzes, suggest topics, power chatbot.
6. **System Implementation:** Develop platform, user interfaces, integrate roles.
7. **Testing & Validation:** Test AI accuracy, usability, and system performance.
8. **Deployment:** Publish system for real users online.
9. **User Training & Documentation:** Provide manuals, guides, training for instructors and students.

**1.9 Project / Product Schedule Risks**

**1.9.1 Schedule Risk**

* Delays may occur due to AI model integration, file handling, or unforeseen bugs.

**1.9.2 Impact**

* Reduced testing time could affect stability and quality.

**1.9.3 Mitigation Strategies**

1. Begin AI research concurrently with UI/UX design.
2. Use pre-trained NLP models to speed development.
3. Implement fallback mechanisms for simplified quiz generation.
4. Add buffer periods and conduct weekly progress reviews.

**1.10 Report Organization**

* **Chapter 2** – Theoretical Background & Literature Review: Existing AI learning tools.
* **Chapter 3** – Requirements Analysis: Functional and non-functional system requirements.
* **Chapter 4** – Software Design: System architecture, database schema, UI prototypes.

**1.11 Operational Definitions**

* **System** → The Quiz AI platform.
* **User** → Any individual interacting with the system.
* **Instructor** → Uploads materials, approves content, manages quizzes.
* **Student** → Studies materials, selects topics, takes quizzes.
* **Admin** → Manages accounts, access rights, and system settings.
* **Knowledge Base** → Collection of study resources.
* **Topic** → Subject area for quiz questions.
* **Quiz** → Automatically or instructor-generated questions.
* **Question Bank** → Repository of questions.
* **Competitive Exam Mode** → Multiple students compete for points.
* **Self-Assessment** → Quiz mode with instant results.
* **Gamification** → Levels, points, badges for engagement.
* **Content Approval** → Instructor validation of AI content.
* **Exam Log** → Records of quiz attempts.
* **AI Suggestion** → Recommendations on topics and questions.
* **Voice Reading** → System reads quiz questions aloud.
* **Chatbot Assistant** → Conversational tool for content questions.
* **Tool Support** → Additional resources like calculators or whiteboards.
* **Academic Integrity** → Ensures fair quizzes/exams.
* **Data Privacy** → Protects user data.

# Theoritical Background & Literature Review

This chapter explores the theoretical foundations and prior research relevant to AI-driven quiz generation and multimedia learning tools. It begins with an overview of artificial intelligence and its role in processing multimodal content, followed by the process of AI-generated quiz creation. The chapter then reviews AI-powered multimedia generation models—ranging from text-to-text, text-to-image, text-to-audio, and text-to-video—and their applications in education. Finally, it examines existing AI quiz-generation tools, their functionalities, challenges, and emerging trends, providing a basis for understanding how this project builds upon and extends current technologies.

**2.1 Artificial Intelligence (AI) Overview**

The field of artificial intelligence (AI) is concerned with building machines that are able to carry out operations like perception, reasoning, and decision-making that normally call for human intelligence. Rule-based systems gave way to data-driven machine learning in modern AI, with large-scale deep learning models—particularly transformers—being the driving force behind recent advances. These days, large language models (LLMs) like GPT (OpenAI, 2025), Llama (Meta AI, 2024), Claude (Anthropic, 2024), and Gemini (Google DeepMind, 2024) serve as flexible reasoning engines that can process multimodal inputs, text, and code.

By processing text, audio, images, and video in a single pipeline, multimodal AI expands these capabilities (Yin et al., 2024) even further, opening the door for uses like lecture transcription and analysis. While parameter-efficient fine-tuning techniques (e.g., LoRA) enable cost-effective customization (Hu et al., 2022) for domain-specific tasks, retrieval-augmented generation (RAG) techniques increase accuracy (Lewis et al., 2020) by connecting models to external knowledge sources. Strong text-to-image, audio, and video models are another example of generative AI advancements that increase the creative and analytical potential.

AI is better able to handle big, complicated datasets, like complete lecture transcripts, when it has longer context windows and uses agent-like tools. In addition to these capabilities, safety, alignment, and governance frameworks are becoming more and more important in order to ensure responsible deployment, particularly in delicate areas like education.

**2.2 AI-Generated Quiz Creation Process**

A multi-step process that combines knowledge comprehension, question formulation, and content extraction is used to create AI-generated quizzes. The system starts by ingesting source material, such as documents, audio recordings, videos, or lecture transcripts. Automatic speech recognition (ASR) transforms audio into text for non-text inputs, and optical character recognition (OCR) pulls text from slides or pictures.

Natural language processing (NLP) is applied to the extracted text in order to pinpoint important ideas, connections, and learning goals. Retrieval-augmented generation (RAG) guarantees that questions generated are based on the original content, while summarization models distill extensive content into targeted sections. These concepts are converted into multiple-choice, fill-in-the-blank, true/false, and short answer question formats by large language models (LLMs) like GPT or LLaMA, which are frequently refined using educational datasets.

Based on student performance data or frameworks such as Bloom's Taxonomy, dynamic difficulty adaptation is feasible. These capabilities are demonstrated by platforms that support multimodal inputs and customizable outputs, like Questgen AI (2025), Quizbot AI, and VidVersityQG (Shahid, Hussain, & Shoaib, 2021). This procedure is a useful tool in contemporary education since it not only automates the creation of assessments but also customizes tests for focused revision.

**2.3 AI Multimedia Generating Tools**

**2.3.1 Overview**

Artificial intelligence systems created to automate or support the production of different media types, such as text, images, audio, video, animation, and interactive content, are referred to as AI multimedia tools.

In order to produce richer and more captivating user experiences, multimedia generally integrates various types of content—such as text, images, audio, and video—into a single presentation. Through features like games, quizzes, and clickable elements, interactive multimedia makes content more dynamic and personalized while encouraging active user participation.

The creation of content has changed dramatically as a result of AI developments. AI can create organized and cohesive textual content, including blog posts, reports, and articles, thanks to Natural Language Processing (NLP). While AI-powered tools support music composition, sound editing, voice synthesis, video production, and animation, Generative Adversarial Networks (GANs) and other generative models help create realistic images. When taken as a whole, these innovations facilitate customized multimedia experiences, improve creative efficiency, and lessen manual labor.

**2.3.2 Text-to-Text Generation Models**

The creation of content has changed dramatically as a result of AI developments. AI can create organized and cohesive textual content, including blog posts, reports, and articles, thanks to Natural Language Processing (NLP). While AI-powered tools support music composition, sound editing, voice synthesis, video production, and animation, Generative Adversarial Networks (GANs) and other generative models help create realistic images. When taken as a whole, these innovations facilitate customized multimedia experiences, improve creative efficiency, and lessen manual labor.

Institutions should create adaptable policies, train employees and students on moral AI use, and rethink tests to prevent abuse in order to meet these challenges. In order to identify AI-generated content, human judgment is still essential. In the AI era, preserving academic integrity requires involving students in policy-making and implementing a cooperative community approach.

**2.3.3 Text-to-Image Models**

AI programs that can produce images straight from descriptions in natural language are called text-to-image models. They allow users to create visuals that correspond with particular prompts by bridging the gap between linguistic and visual modalities.

Current methods consist of:

1. GAN-based Models: Using a generator–discriminator framework, Generative Adversarial Networks generate realistic images that correspond with text descriptions.
2. Diffusion Models: Stable Diffusion and DALL·E 2 gradually convert noise into coherent images through prompt-guided denoising steps.
3. Transformer-based Models: Use transformer architectures to model the relationships between text and visual elements for fine-grained image control.
4. Hybrid Approaches: Utilize a variety of methods to optimize semantic accuracy and visual quality.

Applications: Digital art, marketing, product design, and instructional content production.

**2.3.4 Text-to-Audio/Voice Models**

Applications such as voice assistants, audiobooks, and music composition are made possible by these AI systems, which use text as input to produce speech, music, or sound effects. Examples include Uber’s Jukebox and Google WaveNet.

**2.3.5 Text-to-Video Models**

New AI technologies automate video production processes by producing video content from minimal inputs or text descriptions. While still in the early stages of development, platforms such as Google’s VEO 3, Meta’s Make-A-Video, and Runway Gen-2 show promise.

**2.3.6 Use Cases in Education**

By creating rich, context-specific visual materials that are suited to different learning styles, text-to-image models can improve education by increasing engagement and comprehension (Chen & Wang, 2022).

* Less manual design is required because teachers can produce original diagrams, infographics, and illustrations aligned with lesson goals.
* Students can visualize historical occurrences, scientific procedures, and abstract ideas to improve memory and creativity.
* These resources can be incorporated into courses in creative fields like media studies, design, and art.
* Inclusive education benefits from accessible and culturally appropriate imagery for diverse linguistic contexts and students with disabilities.

A screen shot of a graph

AI-generated content may be incorrect.

***Figure 2.1: Student AI Usage Statistics. Adapted from Digital Education Council Global AI Student Survey (2024).***

* 86% of students already use AI in their studies.
* 54% use AI daily or weekly, with 24% using it daily.



**Figure 2.2: Student AI Usage Statistics. Adapted from *Digital Education Council Global AI Student Survey* (2024).**

* Note: 86% of students use AI in their studies; 54% use AI daily or weekly, with 24% using it daily.

**2.3.7 Challenges and Ethics**

Even though AI multimedia tools have a lot of potential, their responsible use requires addressing key challenges:

* **Content Quality & Reliability:** AI may generate biased, erroneous, or misleading results.
* **Bias & Fairness:** Training data can reinforce stereotypes, affecting inclusivity.
* **Intellectual Property & Copyright:** AI may unintentionally replicate existing works.
* **Misinformation Risks:** Misuse for deepfakes or fake news undermines trust.
* **Privacy & Data Protection:** Sensitive data use raises ethical and legal concerns.

**Solution:** Collaboration among technologists, educators, policymakers, and ethicists is needed to ensure accountability, transparency, and fairness.

**2.4 AI Tools to Generate Quizzes**

**2.4.1 Introduction**

By making it possible to create quizzes automatically, the development of artificial intelligence (AI) has drastically changed educational assessment. Natural language processing (NLP) and machine learning (ML) algorithms are used by AI-driven quiz generation tools to produce a variety of assessments that can be customized to meet the needs of each learner. These resources have the potential to support adaptive learning environments, increase instructional efficiency, and offer instant feedback (Alsmadi & Almarashdeh, 2023). The basic processes underlying AI quiz creation, the range of question types generated, and the main advantages, difficulties, and restrictions related to their use in education are all covered in this section.

**2.4.2 How AI Quiz Tools Work**

AI quiz generation systems employ a combination of Natural Language Processing (NLP), Machine Learning (ML), and large language models (LLMs), such as GPT, to automatically generate questions from educational materials. NLP techniques allow systems to parse text, discover, and extract concepts, as well as to discern relationships between concepts and ideas. ML algorithms allow systems to identify existing patterns in question banks and learner performance data, and to formulate more contextualized and accurately structured questions. More advanced systems can include large language models that can actually create a new piece of content, paraphrase a complex idea, and be able to change the complexity of the language to an appropriate level for the audience. Most systems can accept a range of formats—like documents, lecture transcripts, or video—and produce diverse question formats, such as multiple-choice, true/false, open-ended, and scenario-based items. Finally, the system usually produces a validation step to ensure pre-generated questions meet learning objectives and standards for clarity and accuracy before being distributed for final delivery.

**2.4.3 Types of Questions Generated**

Artificial intelligence quiz tools generate many types of questions, and their benefits are specific to their academic purpose. Multiple-choice questions (MCQs) are the most common format - students demonstrate recognition and recall by choosing from several answering options and only one correct answer to complete the task. True/False questions are valuable when quickly assessing binary knowledge statements, as they allow the user to collect many responses to evaluate factual understanding quickly. Short-answer responses allow for a gravitational active recall process as students generate short responses. More advanced AI systems allow for open-ended or essay-style questions that can assess higher-level thinking skills such as critical thinking, synthesis, and application. Because AI quiz tools can generate many question types, they can provide a range of assessment strategies to assess different learning styles and objectives.

**2.4.4 Personalization and Adaptivity**

Although there have been some good examples of progress, the vast majority of tools for AI quiz generation today, provide little to no genuine personalization/adaptivity. Most often, these tools provide static quizzes which do not change the difficulty of questions or change topic depending on learner performance or preferences. Similarly, feedback systems are basic, and offer little if any, meaningful suggestions to assist the learner in their progression. These various forms of lack of adaptivity, means learners are having generic learning experiences that take advantage of the limited personalization/adaptiveness, thus also limiting the overall utility and engagement with educational opportunities.

**2.4.5 Challenges and Limitations**

AI quiz tools are capable of generating questions only too easily, but a consistent challenge is generating coherent and context-related choice options. These tools, including Quizlet, Quizziz, Kahoot, QuestionPro, and ProProfs, often produce distractors that are completely unrelated to the question stem, i.e., a question that pertains to a date, has distractors that include ocean names or phrases that are unrelated (Observations, 2025). This is not only a misuse of an assessment tool, but it also detracts from the overall validity of the assessment. Also, many tools limit the characters of the questions and answer options, which limits their complexity and clarity. The inability to scale question difficulty is also widespread, limiting tools' ability to be effective for learners of multiple abilities. Overall, these issues result in poor quality, reliability, and use in the teaching/learning process of AI-created quizzes (Observations, 2025).

**2.4.6 Future Trends**

The rising use of advanced large language models (LLMs) like GPT, Gemini, and related technologies is one of the most exciting developments in AI quiz generation. When compared to traditional quiz methods, LLMs can produce better quality quiz questions, and aspects of difficultly will be contextualized, which allows for more personalized learning opportunities. However, the LLM strength still produces quizzes in a relatively static/non-interactive way, as the AI-generated quiz still provides limited real-time adaptivity when creating quizzes that are intended to engage the learner and give them dynamic real-time feedback. Future research and development of LLMs are likely to focus on integration with interactive platforms for assessment, to allow for a more adaptive experience, producing courses that are more immersive and responsive to students needs.

# Requirement Clollection/ENGENERRING AND Analysis

This chapter defines the functional and non-functional requirements of the proposed Quiz AI system, along with its constraints and stakeholder interactions. It begins by identifying primary, secondary, and tertiary stakeholders, then outlines detailed software requirements covering authentication, content management, quiz generation, and reporting. Functional requirements are expressed through use cases, while non-functional requirements highlight performance, security, usability, and scalability aspects. The chapter also presents system constraints across resources, technology, operations, and external factors. Finally, software diagrams—including use case, context, and data flow diagrams—illustrate the system’s structure and data interactions, providing a comprehensive view of its expected functionality.

**3.1 Stakeholders**

**3.1.1 Primary Stakeholders**

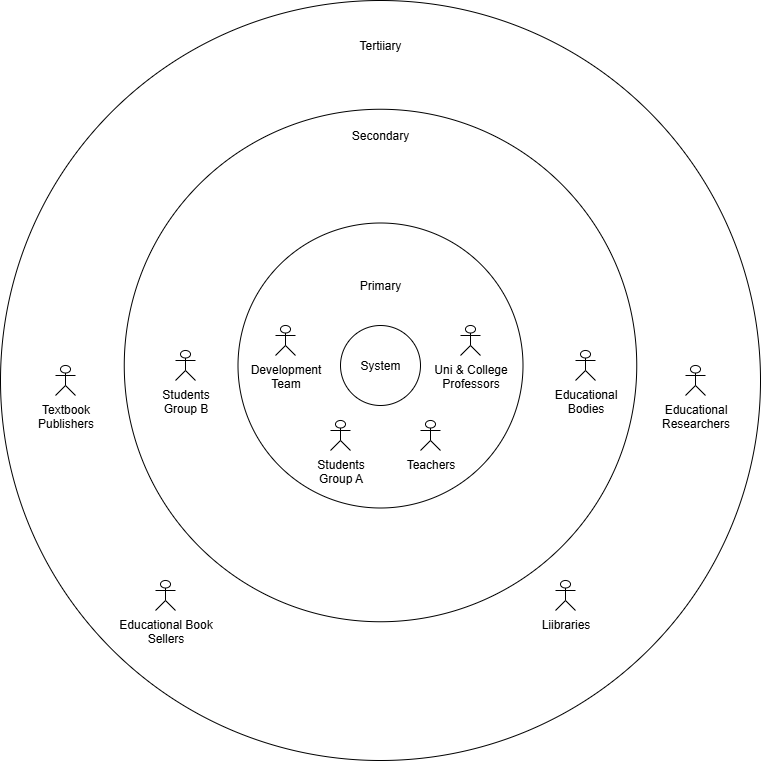
* **Development Team**: Responsible for building and maintaining the system, thus its success or failure directly impacts them.
* **Students – Group A (Direct Users)**: Actively use the system as a tool for studying and reviewing their learning materials.
* **Teachers**: Benefit from AI-generated quizzes and exams, making assessment preparation faster and easier.
* **College & University Professors**: Similar to teachers, they leverage the AI system to efficiently generate quizzes and exams for higher-level courses.

**3.1.2 Secondary Stakeholders**

* **Students – Group B (Indirect Users)**: While they do not use the system directly, they may still take quizzes and exams created by it.
* **Educational Bodies**: Although not direct users, institutions may need to license or purchase the rights to use the system.

**3.1.3 Tertiary Stakeholders**

* **Textbook Publishers**: May experience reduced demand for premade question banks, negatively impacting sales.
* **Educational Researchers**: Interested in studying how AI usage influences assessment quality and student learning outcomes.
* **Educational Book Sellers & Libraries**: As schools rely more on AI-generated quizzes, demand for printed quiz books and related library resources may decrease.

****

**Figure 3.1: Stakeholders Diagram for the Quiz AI system, showing the primary, secondary, and tertiary stakeholders.**

**3.2 Software Requirements**

1. **User Authentication and Security**
   * Users (students, instructors, admins) must be able to log in securely using their username and password.
   * Users must be automatically logged out if sessions remain idle for too long.
2. **Password Recovery**
   * Users must be able to reset their password through email verification.
   * Users must receive a password reset link or token if they forget their password.
3. **Content Management**
   * Students and instructors must be able to upload content (e.g., lecture slides, PDFs, videos) to generate quizzes.
   * Users must not be able to upload duplicate content files.
4. **Quiz Generation**
   * Users must be able to generate quizzes from uploaded content.
   * Users must be able to choose quiz difficulty level and number of questions.
   * Users must be able to access public quizzes, while private ones remain hidden.
   * Students must be able to view top attempts for public quizzes.
5. **Exam Creation and Publishing**
   * Instructors must be able to create and publish quizzes/exams.
   * Instructors must be able to set attempt limits for each quiz/exam.
6. **Quiz Participation**
   * Students must be able to attempt quizzes/exams within a time limit set by the instructor.
   * Students must have a secure and uninterrupted session during attempts.
7. **Results and Analytics**
   * Students must be able to view their quiz results and weak areas in specific chapters.
   * Instructors must be able to view analytics such as average marks, highest scores, and lowest scores.
8. **Error Handling and Logging**
   * Users must be notified if errors occur during login, uploads, or quiz attempts.
   * The system must ensure critical errors are escalated to administrators.
9. **Administrative Functions**
   * Admins must be able to manage users and their permissions.
   * Admins must be able to generate statistical reports about system usage and performance.

**3.3 Functional User Requirements (Use Case Specifications)**

**1. Login to the System**

**Actor(s):** Student, Instructor, Admin  
**Description:** User enters username and password to access the system.  
**Precondition:** User has an active account.

**Normal Flow:**

1. User navigates to the login page.
2. User enters username and password.
3. System verifies credentials.
4. System grants access to the dashboard.

**Alternate Flow:**

* If credentials are incorrect, the system displays an error message.
* If multiple failed attempts occur, the account is temporarily locked.

**Postcondition:** User is logged in and can access system features.

**2. Handle Login Errors (Acceptance/Denial)**

**Actor(s):**System  
**Description:** System validates credentials and either accepts or denies access.  
**Precondition:** Login request is made by the user.

**Normal Flow:**

1. System checks username and password against the database.
2. If valid, grants access.
3. If invalid, denies access.

**Alternate Flow:**

* System suggests *Forgot Password* after multiple failed attempts.

**Postcondition:** Access is either granted or denied.

**3. Forgot Password Request**

**Actor(s):** Student, Instructor, Admin  
**Description:** User requests password reset through the system.  
**Precondition:** User cannot log in to the system.

**Normal Flow:**

1. User clicks *Forgot Password*.
2. System prompts for registered email address.
3. User enters email address.
4. System sends password reset email.

**Alternate Flow:**

* If email is not registered, the system shows an error message.

**Postcondition:** Password reset email is sent to the user.

**4. Send Password Reset Email**

**Actor(s):** System  
**Description:** Email Control System sends password reset email via Email Service.  
**Precondition:** Password reset request has been made.

**Normal Flow:**

1. System generates password reset token.
2. System sends email with password reset link.

**Alternate Flow:**

* If email service is unavailable, the system logs an error and retries later.

**Postcondition:** User receives password reset email.

**5. Upload Content (Lecture or Exam Material)**

**Actor(s):** Student  
**Description:** Student uploads lecture content for quiz generation.  
**Precondition:** User is logged in and has permission to upload.

**Normal Flow:**

1. User navigates to upload section.
2. User selects content file.
3. System validates file format and size.
4. System stores the content.

**Alternate Flow:**

* If file is invalid, the system displays an error message.

**Postcondition:** Content is uploaded and ready for quiz generation.

**6. Generate Quiz from Uploaded Content**

**Actor(s):** Quiz AI Generation Engine  
**Description:** System processes content and generates a quiz using AI.  
**Precondition:** Content has been successfully uploaded.

**Normal Flow:**

1. System processes uploaded content.
2. AI analyzes content and generates questions.
3. System stores generated quiz.

**Alternate Flow:**

* If processing fails, the system logs an error and notifies the user.

**Postcondition:** Quiz is generated and stored in the system.

**7. View Generated Quiz**

**Actor(s):** Student  
**Description:** Student reviews the AI-generated quiz.  
**Precondition:** Quiz has been generated.

**Normal Flow:**

1. User navigates to quizzes section.
2. User selects generated quiz.
3. System displays the quiz.

**Alternate Flow:**

* If quiz is not available, the system shows an error message.

**Postcondition:** User views the quiz.

**8. Create Public Exam**

**Actor(s):** Instructor  
**Description:** Instructor creates and publishes an exam for public access.  
**Precondition:** Instructor is logged in.

**Normal Flow:**

1. Instructor navigates to exam creation page.
2. Instructor sets exam details and questions.
3. Instructor publishes the exam.

**Alternate Flow:**

* If publishing fails, the system shows an error message.

**Postcondition:** Exam is publicly available.

**9. View Public Exam Results and Analytics**

**Actor(s):** Instructor  
**Description:** Instructor checks analytics and results of public exams.  
**Precondition:** Exams have been conducted.

**Normal Flow:**

1. Instructor navigates to analytics section.
2. System displays exam performance data.

**Alternate Flow:**

* If data is unavailable, the system notifies the user.

**Postcondition:** Instructor views analytics.

**10. Access Quiz Results and Reports**

**Actor(s):** Student  
**Description:** Student checks performance and results after taking a quiz.  
**Precondition:** Quiz attempt is completed.

**Normal Flow:**

1. User navigates to results section.
2. System displays quiz results and reports.

**Alternate Flow:**

* If results are delayed, the system notifies the user.

**Postcondition:** User views quiz results.

**11. Request Statistical Reports**

**Actor(s):** Admin  
**Description:** Admin requests system analytics and reports.  
**Precondition:** Admin is logged in.

**Normal Flow:**

1. Admin navigates to reporting section.
2. System generates statistical reports.
3. System displays the reports.

**Alternate Flow:**

* If report generation fails, the system logs an error.

**Postcondition:** Admin views system analytics.

**12. Handle System Errors (Error Control System)**

**Actor(s):** System  
**Description:** System logs and manages errors during processes.  
**Precondition:** System encounters an error.

**Normal Flow:**

1. System detects an error.
2. System logs error details.
3. System notifies relevant stakeholders.

**Alternate Flow:**

* If error persists, the system escalates to technical support.

**Postcondition:** Errors are managed and logged.

**3.4 Non-Functional Requirements**

**3.4.1 Execution Qualities**

* **Safety**  
  The system shall reject quizzes that are inappropriate, harmful, or offensive. Errors that could confuse students or undermine academic integrity shall be avoided.
* **Security**  
  The system shall protect user data through safe authentication (e.g., secure password policies and optional two-factor authentication). Sensitive data, including user credentials, shall be encrypted during both storage and transmission. User activities shall be logged for security auditing.
* **Usability**  
  The system shall provide a user-friendly and intuitive interface, making it accessible for users with limited technical skills. Accessibility features shall be supported, and user manuals/help guides shall be provided.
* **Performance Efficiency**  
  The system shall provide a response time of less than five seconds for common operations. It shall support up to 250 concurrent users without performance degradation and ensure scalability to handle increased demand.
* **Reliability & Availability**  
  The system shall ensure at least 99% uptime and allow automatic recovery from failures. Data shall be backed up daily to prevent loss. The system shall be accessible 24/7 except during scheduled maintenance, with downtime not exceeding 5 hours per month. Real-time notifications shall be provided during outages.

**3.4.2 Evolution Qualities**

* **Testability**  
  The system shall support comprehensive testing, including unit, integration, and performance testing, to ensure correctness and reliability.
* **Maintainability**  
  The system shall follow a modular architecture with proper documentation to enable easy bug fixes, updates, and feature additions. Updates shall be deployable with minimal downtime.
* **Portability**  
  The system shall be deployable across Windows, Linux, and macOS platforms and support both desktop and mobile web browsers. It shall be easily transferable to cloud environments.
* **Scalability**  
  The system shall allow horizontal and vertical scaling to handle workload increases. Future expansions shall support up to 10,000 users and integration with cloud services.
* **Interoperability**  
  The system shall integrate with existing educational tools and platforms. It shall support standard data exchange formats (e.g., JSON, XML) and provide APIs for third-party integration.
* **Legal and Compliance**  
  The system shall comply with relevant data protection regulations (e.g., GDPR). Copyrighted content shall not be used without proper licensing, and institutional policies on academic integrity shall be respected.

**3.5 Constraints**

**a. Resource Constraints**

* **Financial Resources:** The development and operation of the Quiz AI system must stay within the allocated budget, covering expenses such as development, AI model training, testing, deployment, and user training.
* **Human Resources:** Availability of team members skilled in software development, AI/ML, database management, and UX design may impact the project timeline.
* **Time Constraints:** The project must meet milestones for development, testing, and final submission within the semester or allocated timeline.

**b. Technological Constraints**

* **Platform Compatibility:** The system must work across modern web browsers on desktops, laptops, and mobile devices for students, instructors, and admins.
* **Database Performance:** The system must handle multiple concurrent quiz attempts, content uploads, and result queries efficiently.
* **AI and API Dependence:** Features such as quiz generation and content classification rely on AI models and stable API integrations.
* **Security Measures:** The system must use encryption, secure authentication, and input validation to protect user data and prevent unauthorized access.

**c. External Constraints**

* **User Availability:** Successful adoption depends on students, instructors, and admins actively using the system and engaging with training materials.
* **Data Quality:** AI-based quiz generation requires accurate, well-formatted content to produce meaningful quizzes.
* **Network Reliability:** Features like quiz attempts, content uploads, and notifications depend on stable internet connectivity.
* **Legal Compliance:** The system must respect data privacy regulations (like GDPR) and institutional rules regarding academic integrity.

**d. Operational Constraints**

* **Authentication Protocols:** Secure login and session management are required to prevent unauthorized access.
* **Data Synchronization:** Quiz attempts, results, and content uploads must sync across devices in real time.
* **Error Handling:** The system must provide clear error messages for invalid input, failed uploads, or unsuccessful quiz generation.
* **Audit Trail Maintenance:** Logs of quiz creation, user attempts, and system errors must be maintained for review and quality assurance.

**3.6 Software Diagrams**

A. Usecase Diagram

- The Use Case Diagram provides a high-level view of the system's functionalities and interactions with external actors.

**Figure 3.2: Use Case Diagram For Quiz AI System.**

B. Context Diagram (Equivalent to DFD LV.0)

- The context diagram is an overview of an organizational system that shows the system boundaries, external entities that interact with the system, and the major information flows between the entities and the system.

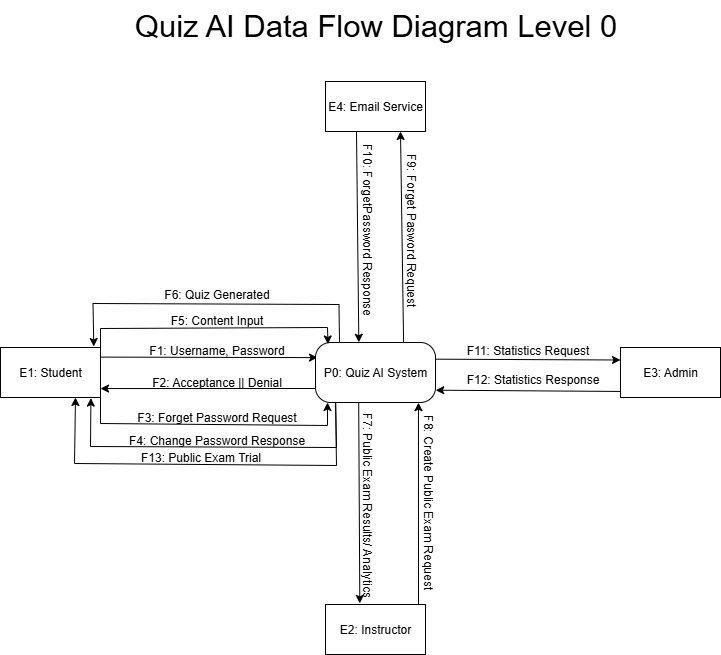
**Figure 3.3: Context diagram of the proposed system.**

Figure 3.3 presents the context diagram of the proposed Quiz AI System. This diagram illustrates the system's interactions with external entities, such as admin, instructors, and students. It provides a clear representation of data flow between the system and these actors, highlighting the system’s role in managing, and creating the quizzes by the system.

C. Data Flow Diagram Level 1

A Level 1 DFD shows the **detailed flow of data within the system**, breaking down major processes from Level 0 into more specific sub-processes. It illustrates **how data moves between actors, processes, and data stores**, helping readers understand the **internal workings of the system**. Level 1 DFDs provide clarity on **data handling, storage, and processing**, making it easier to follow each functional part of the system.

A diagram of a computer

AI-generated content may be incorrect.

**Figure 3.4: Level 1 DFD of the proposed system.**

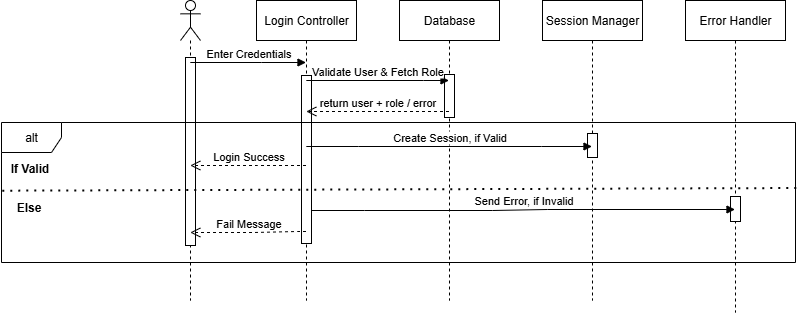
Figure 3.4 illustrates the Level 1 Data Flow Diagram (DFD) of the proposed Quiz AI System. This diagram depicts the main processes of the system, such as quiz creation, generating statistics, and error control. It shows how data flows between various processes, the database, and external entities, providing a clear understanding of the system’s detailed operations and its role in achieving quality assurance objectives at the Quiz AI System.

D. Sequence Diagrams:

A sequence diagram is a type of UML diagram that shows **how objects and actors interact over time** to complete a process. It illustrates the **order of messages**, **activations**, and **conditions** between actors (like users) and system components (like controllers or databases).

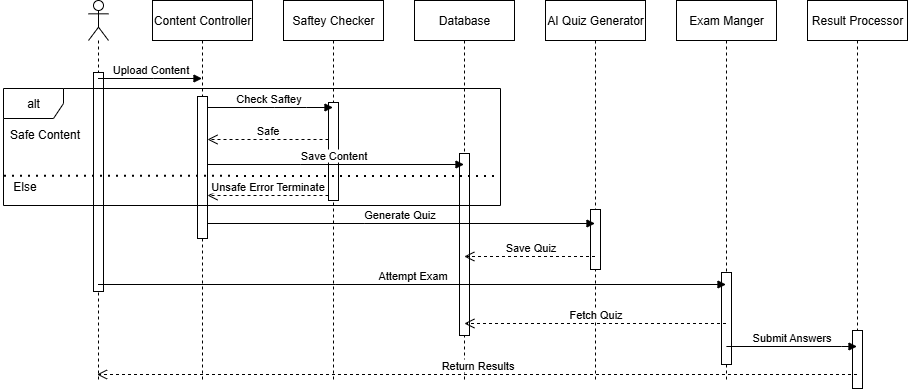
It helps readers understand **step-by-step workflows**, such as login, content upload, quiz generation, or exam attempts, by showing **who does what and in what order**.

* + Login Sequence Diagram:



**Figure 3.5: Login Sequence Diagram.**

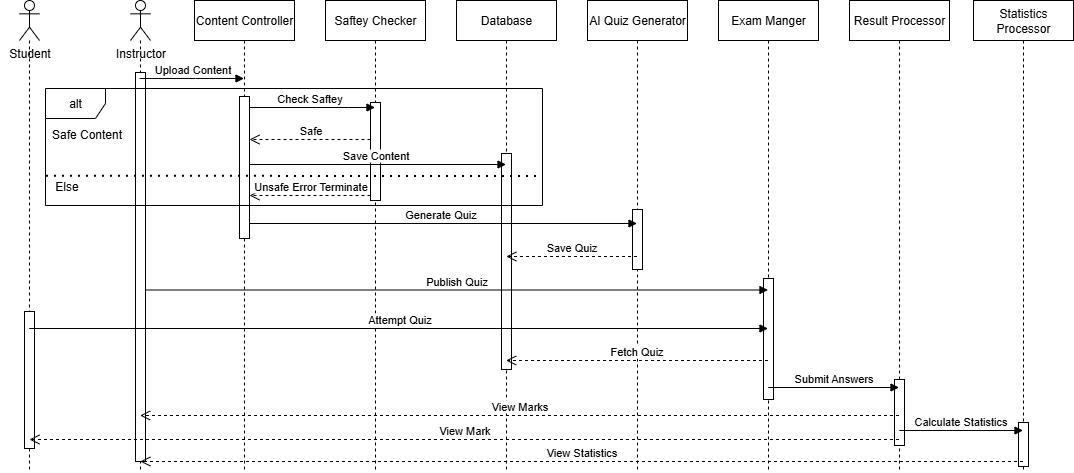
The login sequence diagram illustrates the step-by-step process a user follows to access the system. It shows how the **user interacts with the Login Controller**, how the system **validates credentials and fetches the user’s role from the database**, and how it **creates a session or returns an error**. Conditional fragments indicate the alternative flows for **valid and invalid logins.**

* + Student Attempt Exam Sequence Diagram:

**Figure 3.6: Student Attempt Exam Sequence Diagram.**

This sequence diagram shows how a student interacts with the system to **upload content, generate a quiz, attempt an exam, and receive results**. It illustrates the flow between the **student, content controller, safety checker, database, AI quiz generator, exam manager, and result processor**. Conditional fragments represent **alternative flows**, such as unsafe content or late exam submissions. The diagram provides a clear view of how the system manages content, generates quizzes, handles exam attempts, and returns scores and feedback to the student.

* + Instructor Quiz Management Sequence Diagram

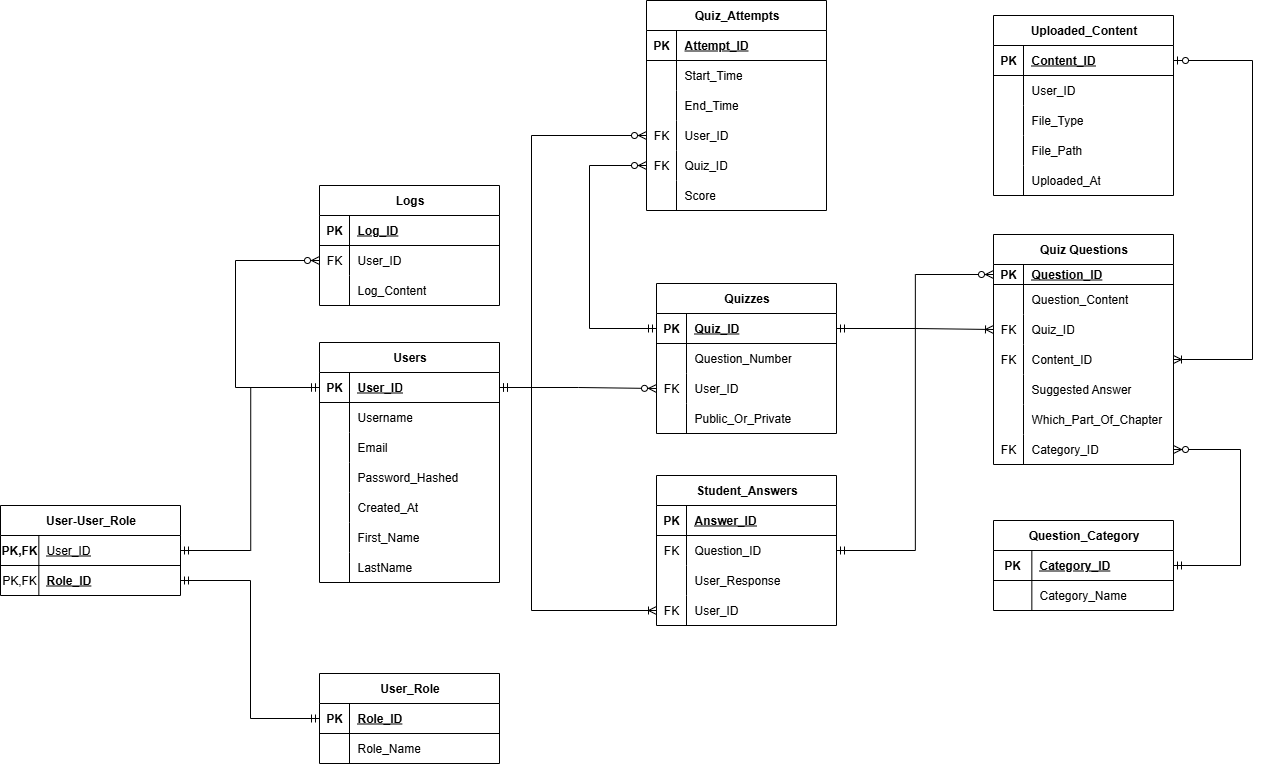


**Figure 3.7: Instructor Quiz Management Sequence Diagram.**

This sequence diagram illustrates how an instructor interacts with the system to **upload content, ensure its safety, generate quizzes via AI, publish them, and monitor student performance**. It shows the flow between the **instructor, content controller, safety checker, database, AI quiz generator, exam manager, result processor, and stats processor**. Conditional fragments capture alternative flows, such as **unsafe content or unapproved quizzes**. The diagram clearly depicts how the instructor manages quiz creation, publication, and accesses **marks and statistical reports** for evaluation.

**3.7 Database Design**

The database design for this project is structured to efficiently store, manage, and retrieve all necessary data related to users, courses, quizzes, and AI-generated content. An Entity-Relationship Diagram (ERD) has been created to visually represent the relationships between different entities, such as Students, Instructors, Admins, Questions, and Knowledge Bases. Each entity includes well-defined attributes, and the relationships ensure data integrity and consistency across the system. The design adheres to the **Third Normal Form (3NF)**, eliminating redundancy and ensuring that each piece of data is stored in only one place, which optimizes query performance and supports scalability and maintainability for future expansions.



**Figure 3.8: Quiz AI Entity Relationship Diagram.**

# Methadology

**4.1 Introduction**

This chapter outlines the methodology followed in the development of the Quiz AI system. It explains the overall approach used to design, implement, and evaluate the system, highlighting the frameworks, models, and tools that guided the process. The chosen methodology emphasizes flexibility, adaptability, and continuous improvement, ensuring that the project can respond effectively to evolving requirements and feedback. Industry-recognized practices such as Agile software development, layered architecture, and structured testing were adopted to provide a systematic framework for building a reliable and scalable solution. Each section of this chapter discusses a key aspect of the methodology, from the project development approach and system architecture to tools, technologies, data collection, testing, and user interface design.

**4.2 Project Development Approach**

Our project follows the Agile Software Development Model. We chose this approach because it emphasizes flexibility, iterative development, and continuous improvement, which suit our project's dynamic nature. The system we are building includes user authentication, content upload, AI-based quiz generation, public exam creation, and analytics. It needs frequent adjustments based on feedback from stakeholders and changing requirements. Agile lets us make these changes without disrupting the overall development process.

Agile development works in short iterative cycles called sprints. Each sprint produces a functional part of the system. After each iteration, we gather feedback from stakeholders and make necessary refinements. This helps ensure that the final product is functional and meets user needs and expectations.

**The advantages of Agile for this project include:**

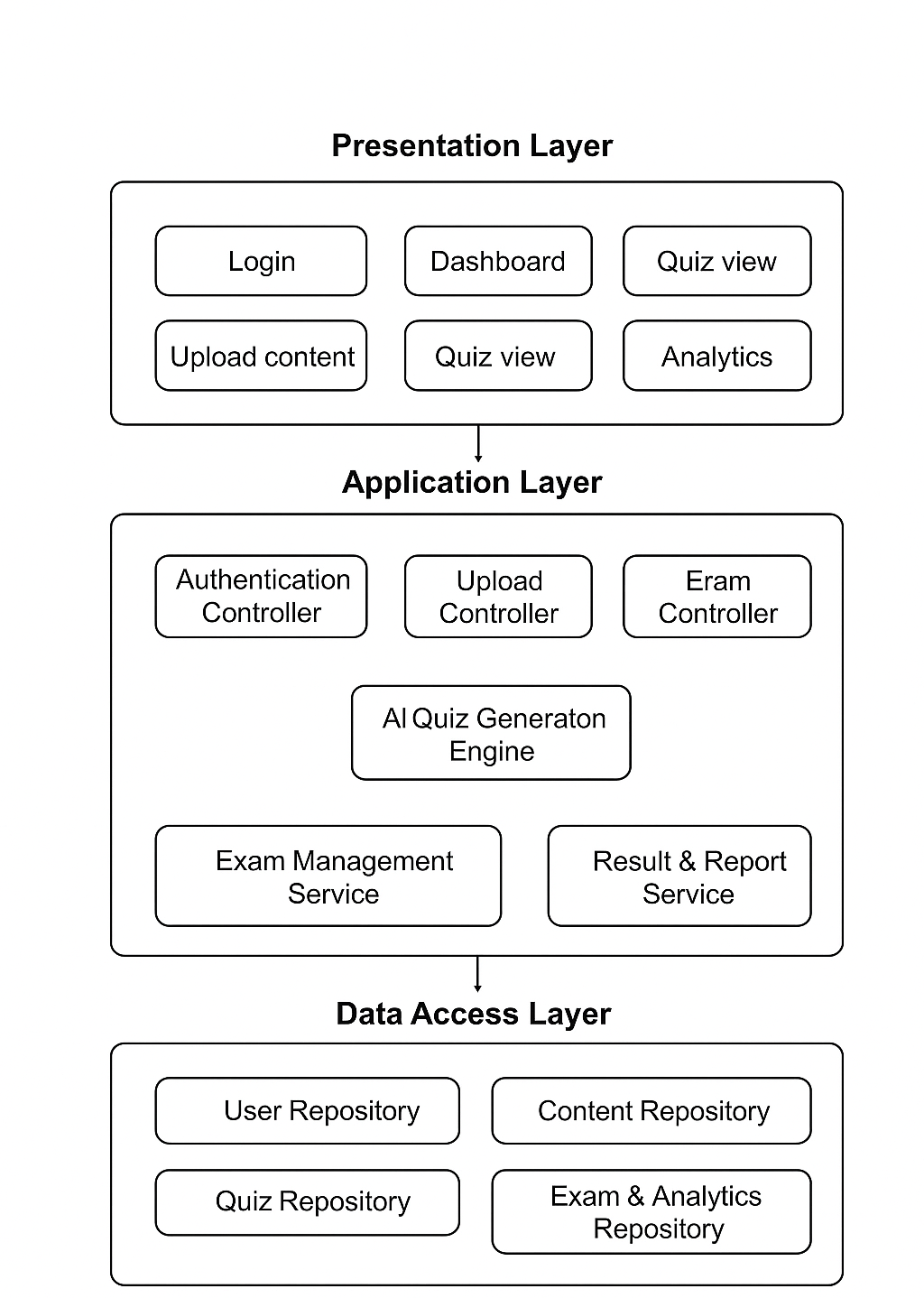
* Adaptability: We can modify or improve features and user interfaces during development without needing complete redesigns or causing significant delays.
* Early Delivery: The system is built step by step, allowing us to deliver functional parts like user login, content upload, or quiz generation early. This enables testing and user validation sooner.
* Customer Collaboration: Agile encourages close communication with stakeholders throughout development. This ensures the product evolves based on actual user requirements rather than assumptions.
* Risk Management: Continuous testing and incremental delivery help reduce the risk of major failures later on. Issues are identified and resolved early.

**The project will progress through the following phases, repeated in cycles:**

1. **Planning**: Define the overall scope of the system, prioritize features, and create a backlog of tasks for each sprint.
2. **Design**: Develop detailed user interface (UI) mockups, database architecture, and integration diagrams to clarify the technical structure.
3. **Implementation**: Code the core functionalities of the system, such as authentication, content upload, AI quiz generation, exam management, and analytics modules. Each feature is built incrementally during sprints.
4. **Testing**: Conduct rigorous testing at multiple levels. This includes unit testing for individual components, integration testing for module interactions, and user acceptance testing (UAT) to validate requirements.
5. **Deployment**: Release working versions of the application to a staging environment for stakeholder review, followed by full deployment to production.
6. **Maintenance & Continuous Improvement**: Address any issues reported post-deployment, release updates, add new features based on feedback, and enhance system performance and usability.

**4.3 System Architecture**

The layered architectural style was chosen for this software system because it organizes functions into separate layers. This structure promotes the separation of concerns by dividing the system into independent layers, each handling a specific group of related tasks. This setup improves maintainability, scalability, and testability by allowing changes within one layer without greatly affecting the others. It also makes the code easier to read and establishes a clear dependency direction, where upper layers depend on lower layers, which reduces coupling. These benefits make the layered architecture an excellent choice for complex systems that need clarity, modularity, and long-term flexibility.



**Diagram 4.1: Quiz AI Software Architecture.**

This diagram illustrates the three-tier layered architecture of our Quiz System, dividing the application into logical and distinct layers: the Presentation Layer, the Application Layer, and the Data Access Layer. This structured approach enhances modularity, maintainability, and scalability.

1. **Presentation Layer:** This is the topmost layer, responsible for the user interface and handling all user interactions. It presents information to the user and captures their input. Key components here include:
   * **Login:** Manages user authentication and session initiation.
   * **Dashboard:** Provides an overview and quick access to system functionalities.
   * **Quiz view:** Displays quizzes for users to take and review.
   * **Upload content:** Allows administrators or content creators to add new quiz materials.
   * **Analytics:** Presents insights and reports based on quiz data.
2. **Application Layer:** Often referred to as the Business Logic Layer, this central tier contains the core functionality and business rules of the Quiz System. It processes requests from the Presentation Layer and interacts with the Data Access Layer. Components include:
   * **Authentication Controller:** Manages user login, registration, and session validity.
   * **Upload Controller:** Handles the processing and validation of uploaded content.
   * **Exam Controller:** Orchestrates the creation, management, and delivery of exams/quizzes.
   * **AI Quiz Generation Engine:** A core component responsible for intelligently generating quizzes (e.g., from uploaded content).
   * **Exam Management Service:** Provides services related to scheduling, administering, and monitoring exams.
   * **Result & Report Service:** Processes quiz submissions, calculates scores, and generates performance reports.
3. **Data Access Layer:** This bottom layer is responsible for interacting with the database and managing all data persistence operations. It abstracts the underlying database technology from the Application Layer. Components within this layer include:
   * **User Repository:** Handles CRUD (Create, Read, Update, Delete) operations for user data.
   * **Content Repository:** Manages the storage and retrieval of quiz questions, multimedia, and other content.
   * **Quiz Repository:** Deals with saving, loading, and managing quiz definitions and structures.
   * **Exam & Analytics Repository:** Stores data related to conducted exams, user attempts, scores, and information used for analytics.

**4.4 Tools and Technologies**

**Programming Languages**

**C#**  
It is reliable, efficient, and well-suited for building robust backend systems or desktop applications. It integrates seamlessly with .NET libraries, offering strong type safety and excellent performance.  
It reduces runtime errors, provides scalability for large systems, and allows rapid development of stable APIs or services that power the application.

**Python**  
Python is widely used in machine learning and AI development because of its clean syntax, extensive libraries, and community support.  
It enables quick prototyping, easy integration with frameworks like QLoRA and TinyLlama, and fast iteration when building or refining AI components.

**React**  
React is rather ideal for creating web interfaces with a component-based architecture that promotes reusability.  
It also allows a smoother user experience than some alternatives, reduces development effort for the frontend, and ensures scalability as the application grows.

**Frameworks**

**QLoRA**  
QLoRA (Quantized Low-Rank Adaptation) fine-tunes large language models efficiently by lowering memory usage without compromising accuracy.  
It also makes it affordable and practical to adapt advanced AI models to our project requirements.

**TinyLlama API**  
TinyLlama provides a lightweight API for large language model capabilities, focusing on speed and low resource consumption, which is great for the hardware we have access to as developers.  
faster AI responses, reduced latency, and an overall smoother experience for end-users are some of its benefits.  
Additionally due to its highly curated data set it’s does a great job at data extraction and understanding without having to worry about hallucinations.

**Development Tool**

**Microsoft Visual Studio Code**  
Why chosen: VS Code is a lightweight yet powerful code editor with broad language support, integrated debugging, Git control, and an extensive extension marketplace.  
How it helps the project: It increases developer productivity, streamlines workflows across different programming languages, and enables rapid switching between backend, AI, and frontend development.

**SQL Server Management Studio**  
SSMS provides a comprehensive and user-friendly interface for managing SQL Server databases. It's a key tool for database administrators and developers, offering a visual way to design, query, and maintain databases. Its powerful features streamline tasks like performance monitoring, security management, and data backup, ensuring the database is stable, secure, and performant.  
As our backend is powered by C#, we'll be using a SQL Server database for data storage. SSMS is the standard tool for working with this database. It allows us to easily design the database schema, write and debug complex queries, and manage the database's health and security. This is crucial for building a scalable and reliable backend that can handle our application's data needs efficiently.

**Overall Impact**

* Backend stability and scalability (C# + VS Code)
* Fast AI development and integration (Python + QLoRA + TinyLlama)
* Modern, user-friendly frontend (React)
* Efficient resource usage with advanced AI (QLoRA quantization, TinyLlama’s lightweight models)

**4.5 Data Collection and Analysis**

The data collection process for the proposed Quiz AI system focuses on preparing educational resources that can be used to fine-tune the TinyLlama model for quiz generation. Since ready-made datasets for the intended task are limited, multiple sources are considered, including open repositories such as Kaggle and Hugging Face, along with instructor-provided materials like books, lecture slides, and past exams. The collected data is organized into structured formats (e.g., JSON) containing pairs of content and questions, instruction–response samples, and exam-style Q&A sets. Each entry is further enriched with metadata such as subject tags, difficulty levels, and answer types to enhance the model’s ability to generate adaptive and context-aware quizzes. After collection, the data undergoes preprocessing, cleaning, and validation to ensure accuracy and consistency. Finally, the analysis phase examines the dataset coverage across different subjects and levels of difficulty, ensuring it is representative enough for fine-tuning and evaluation.

**4.6 Testing Strategy**

Complete, multi-layered testing will be employed to certify that the Quiz AI is accurate, reliable, and meets all functional and non-functional requirements. The strategy will use automated and manual testing techniques throughout the development process.

**4.6.1 Testing Methodology**

The testing approach will be centered on Unit Testing and Burp Suite.

**Unit Testing:**

* **Objective**: To confirm every single method, function, and class operates correctly independently of the other system parts. It is highly recommended to detect logic bugs as early as possible during the development cycle.
* **Method**: Automated tests will be written by developers for the lowest level of units of code. These are testing functions for text processing, quiz question generation, input validation, and data formatting. External dependencies such as calls to AI APIs or file system calls will be mocked out with mock objects so that tests are fast, consistent, and isolated.
* **Tool**: The project will utilize the unit test framework, Python's default unit test tool. The framework provides a solid base upon which to build and run a solid set of tests.

**Penetration Testing & Security Scanning:**

* **Purpose**: To actively scan and fix security vulnerabilities in the application before it is deployed.
* **Procedure**: The deployed application will be scanned for typical web vulnerabilities systematically. This includes testing injection flaws (SQLi, XSS), broken authentication, insecure direct object reference, and other on the OWASP Top 10 list.
* **Tool**: The primary tool for manual and automated security testing will be Burp Suite. It will be used to intercept, observe, and manipulate HTTP/S requests between the server and client in an effort to find security vulnerabilities.

**4.6.2 Error Identification and Correction**

A transparent process will be employed to deal with problems that are found:

* **Identification**: Problems will be identified by automated unit test failures and security scans.
* **Triage & Logging**: Problems from functional bugs to severe security bugs will be logged, prioritized for repair, and sorted based on severity.
* **Resolution**: Bugs will be repaired by developers, while security bugs will be repaired using a patch. Security patches will be tested to ensure that they do not introduce new vulnerabilities.
* **Validation**: The unit test suite and The Burp Suite will be re-run to verify that the fix is working without causing any regressions.

**4.6.3 Test Cases and Validation**

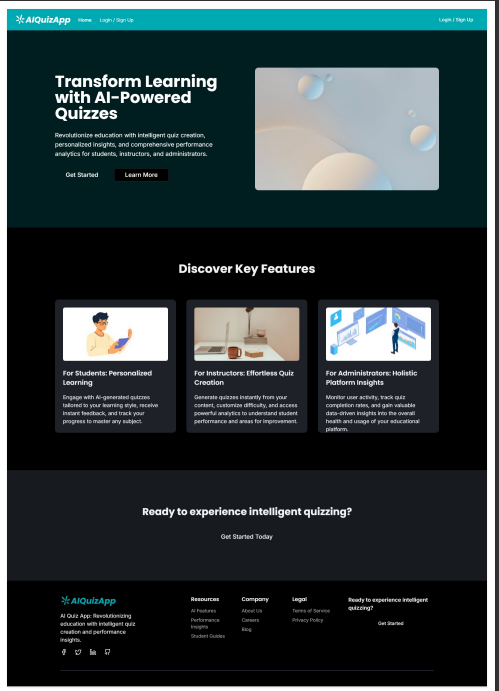
The following table provides examples of test cases for both unit and security testing.

| **TEST CASE ID** | **TYPE** | **DESCRIPTION** | **INPUT EXPECTED** | **OUTCOME** |
| --- | --- | --- | --- | --- |
| TC-U-101 | Unit Test | Test input validation for file upload. | A file with type .exe | Function raises a ValueError. |
| TC-U-102 | Unit Test | Test JSON formatting of a quiz question. | Question data object. | A valid JSON string with correct fields. |
| TC-SEC-201 | Security (Burp Suite) | Test for SQL Injection in login form. | username: admin' -- | Returns a generic error message, not a database error. |
| TC-SEC-202 | Security (Burp Suite) | Test for Cross-Site Scripting (XSS) in quiz output. | <script>alert('test')</script> | Input is sanitized; script tags are not executed. |

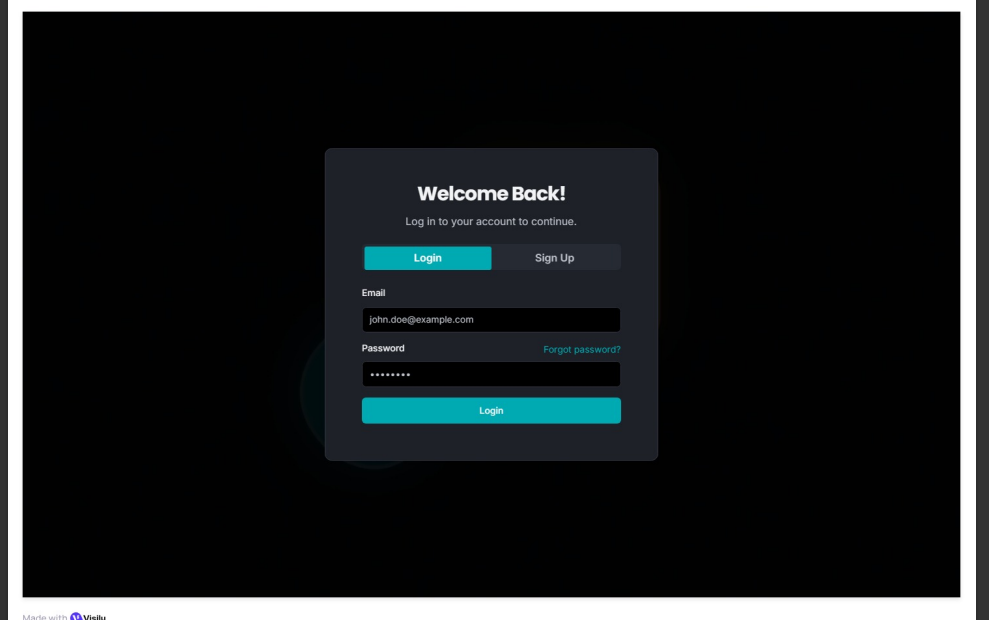
**Table 4.1: Summary of Unit and Security Test Cases for System Validation.**

**4.7 User Interface Design (Prototype)**

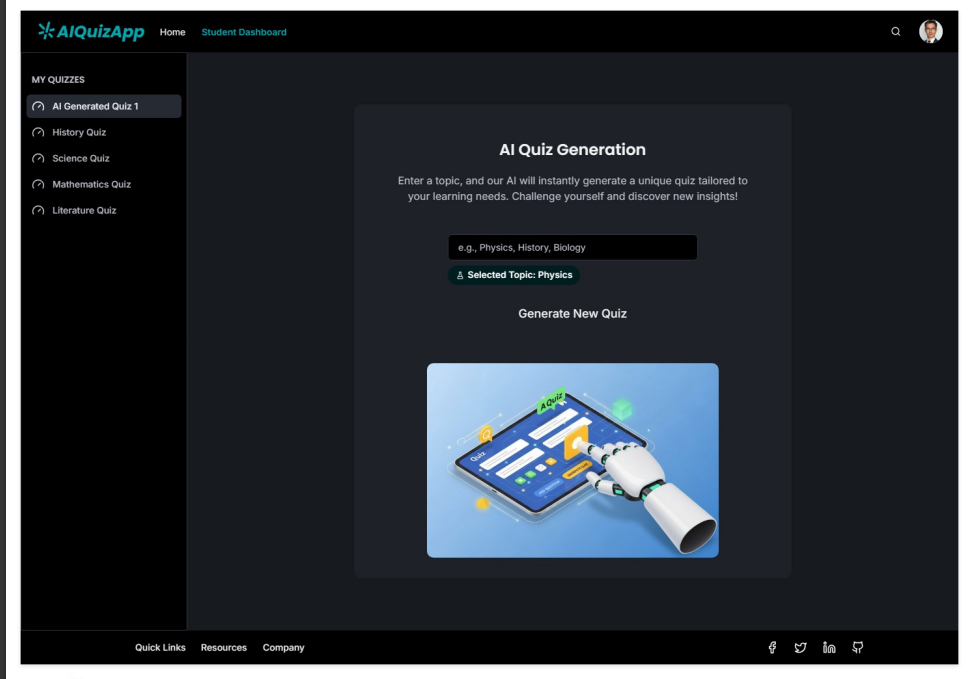
The User Interface (UI) design prototype for this project provides a clear and intuitive layout that guides users through the system’s features, including course selection, quiz taking, and AI-assisted content interaction. The prototype emphasizes usability and accessibility, with consistent visual elements, logical navigation paths, and responsive design principles to ensure a smooth experience across devices. It serves as a preliminary model to gather feedback from stakeholders, allowing for iterative improvements before the final implementation.



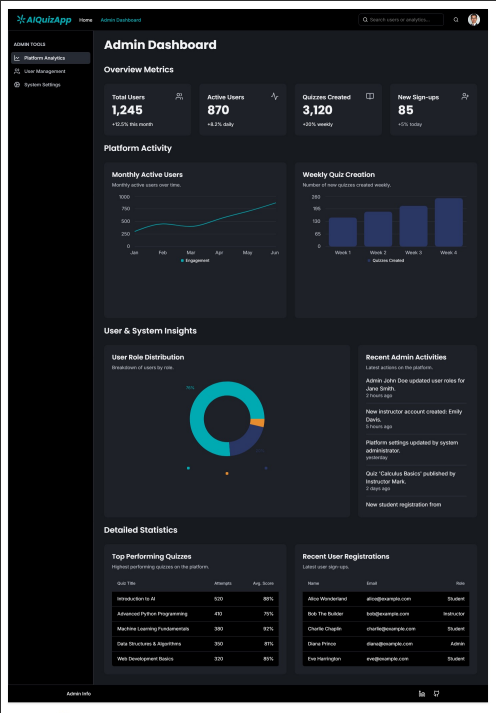
**Figure 4.2: Home Page.**

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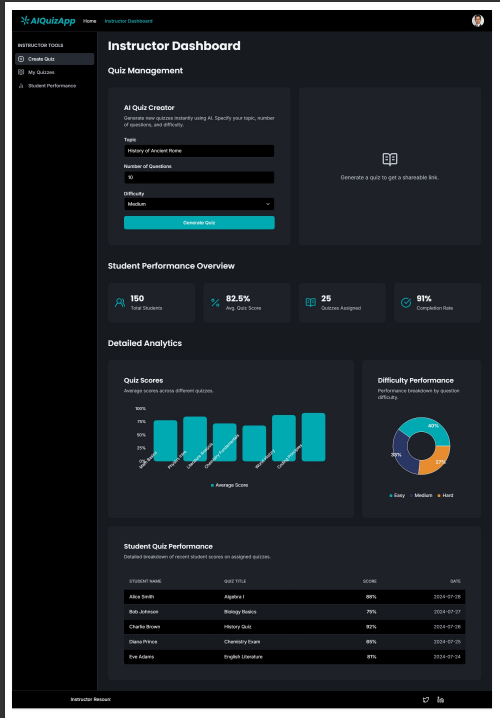
**Figure 4.3: Login Screen.**

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**Figure 4.4: Quiz Generation Page.**

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**Figure 4.5: Admin Dashboard.**

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**Figure 4.5: Instructor Dashboard.**

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