PERSONALIZED ACADEMIC INTERVENTIONS USING ADAPTIVE AND EXPLAINABLE AI: MULTIMODAL LEARNING ANALYTICS FRAMEWORK

25-26J-172

Project Proposal Report

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B.Sc. (Hons) Degree in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

August 2025

CONVERSATIONAL AI ASSISTANT FOR ADAPTIVE ACADEMIC INTERVENTIONS

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DECLARATION

I declare that this is our 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 our 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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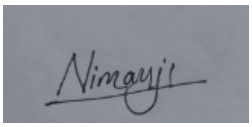
Nimanji D.L. K	IT22365750	

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

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

Signature of the supervisor:

(Ms. Sanjeevi Chandrasiri)

29/08/2025

Date

ABSTRACT

Accessing accurate and timely academic information remains a major challenge for students in higher education. Many students face difficulties understanding emails from administration, keeping track of repeat and prorata registration deadlines, managing payment details, and accessing lecture materials. Traditional Learning Management Systems (LMS) and institutional communication channels are often overwhelming, fragmented, and text-heavy, leading to confusion and missed opportunities for academic success. This research proposes the development of a Conversational AI Assistant for Adaptive Academic Interventions designed to help students quickly find and understand critical information through natural and interactive communication. The proposed solution integrates conversational AI with adaptive academic support features, allowing students to query the system via text, voice, images, or uploaded PDFs. The chatbot will assist students in repeat and prorata module registrations, provide information about deadlines, exam schedules, payment procedures, module details (such as Module codes, learning content, and lecturers-in-charge), and clarify confusing administrative communications such as risk warning emails. Additionally, it will guide students to lecture recordings, course materials, and offer simplified explanations of academic requirements. The system will be developed using Natural Language Processing (NLP) techniques combined with a structured dataset of academic queries. It will be trained in diverse inputs to handle multi-modal prompts and provide context-aware, adaptive responses tailored to individual student needs. The design ensures scalability, accuracy, and inclusiveness by supporting multiple input types and providing explanations in simplified language. This research aims to create a reliable AI assistant that reduces administrative burden, improves student understanding of academic processes, and enhances timely interventions. The outcome will be a scalable chatbot system that not only improves access to academic information but also strengthens student engagement and success by making academic communication clearer, faster, and more supportive

Keywords — Conversational AI, Adaptive Academic Interventions, Multi-modal Chatbot, Learning Management System (LMS), Student Support, Natural Language Processing (NLP), Explainable AI, Academic Communication, Higher Education, Student Engagement

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1. LIST OF ABBREVIATIONS

Abbreviation	**Description**
LMS	Learning Management Systems
NLP	Natural Language Processing
FAQs	Frequently Asked Questions

2. INTRODUCTION

Higher education students typically experience challenges with accessing credible academic information and understanding institutional communications, notably on registrations, deadlines, payments, and exam procedures. Traditional Learning Management Systems (LMS) provide static interfaces of low interactivity, which compel students to sift through enormous amounts of scattered information [1]. Research on educational technology has proven that conversational interfaces can facilitate increasing accessibility, engagement, and learning through enabling students to interact in natural language [2]. Numerous research works have explored the use of chatbots in academic support. For instance, Winkler and Söllner [3] indicated the possibilities of education chatbots to support student motivation, while Tegos et al. [4] outlined how conversational agents enable collaborative learning. However, most existing academic chatbots merely reply to Frequently Asked Questions (FAQs) or provide general administrative guidance. They are less flexible, do not handle multiple input modes, and are unable to explain complex academic interventions in simple terms. To achieve this project, one needs to learn expertise in Natural Language Processing (NLP), intent recognition, and context-aware dialog management. Cutting-edge student question comprehension is achievable using sophisticated models such as transformer-based architectures (e.g., BERT, GPT) [5]. Multi-modal AI techniques also need to be applied for handling non-text inputs such as voice, images, and PDFs. The state of the art in chatbot AI takes advantage of deep learning combined with adaptive learning systems, but their use in universities remains immature, especially in academic interventions. Off-the-shelf solutions rarely provide personalized guidance on repeat -related notifications in a simplified manner. Our approach builds existing work by integrating conversational AI and adaptive academic intervention strategies so that students have access to not only facts, but also customized, simplified explanations. Unlike existing chatbots, the platform supports multi-modal inputs and delivers context-dependent interventions, making it more inclusive and effective for diverse student needs.

2.1 Background & Literature Survey

The fast evolution of LMS has opened new avenues for students to access learning material, register for modules, and track progress. However, students often struggle to use these systems due to scattered information and complex processes. It has been established through research that chatbots and conversational agents can ease information access by providing interactive natural-language interfaces [1]. Several studies enumerate benefits of chatbots in the educational domain. Winkler and Söllner [2] recognized that chatbots raise student engagement and reduce administrative workload. Tegos et al. [3] demonstrated that dialogue-based conversational agents can support collaborative learning. Similarly, Holmes et al. [4] reviewed chatbots in education and highlighted their potential to promote accessibility and inclusivity. Despite these developments, most existing chatbots in university environments are limited to answering FAQs or static responses. They generally lack flexibility, customization, and the ability to handle complex academic intervention needs—such as repeat/prorata module registrations, explaining deadlines, interpreting emails about risk status, or providing basic academic policy clarifications. This creates opportunities for adaptive conversational AI systems.

2.2 Research Gap

Existing academic chatbots are mostly designed as FAQ assistants or administrative aids and are hence specialized in scope. They are likely to be incapable of providing adaptive academic interventions according to individual student requirements, and thus most students remain without customized teaching. In addition, these chatbots are most often unable to support multi-modal interactions such as text, voice, images, or PDFs, which are increasingly applicable for accessibility and ease of use. The second constraint is that they cannot express in simple, readable language complicated academic processes or system-driven risk notifications, which is bewildering to students when dealing with critical academic issues. Also, current solutions do not delve very far into LMS data and institutional workflows to offer truly personalized academic support. To alleviate these constraints, our research promotes the development of a Conversational AI Assistant that integrates adaptive interventions, explainability, and multi-modal support so that learners can access accurate, timely, and easy-to-understand academic information whenever and wherever they require it.

Technologies and methods	Research Paper [1]	Research Paper [2]	Research Paper [3]	Research Paper [4]	Research Paper [5]	Proposed research
Multi-modal Input Handling (Text, Voice, Image, PDF)	✗	✗	✗	✓	✗	✓
Explainability of Academic Processes	✗	✓	✓	✗	✗	✓
LMS Integration for Academic Data	✗	✓	✗	✗	✓	✓
Privacy-Preserving Student Data Handling	✗	✗	✓	✗	✗	✓
Intent Recognition & Entity Extraction	✓	✓	✓	✗	✓	✓

Table 1 Comparison between Existing Research Methods and Proposing Method

2.3 Research Problem

To improve accessibility and personalization, how can a conversational AI assistant be developed to offer adaptive academic interventions that streamline difficult academic procedures, provide clear explanations of system communications, and facilitate multi-modal student interactions?

3. OBJECTIVES

3.1 Main Objective

The aim of this research study is to create a Conversational AI Assistant that gives personalized, multi-modal, and explainable academic support for students. The assistant will be supported by the Learning Management System (LMS) so that quick access to detailed content can be provided, such as details about the modules you are registered for, deadlines for important documents, details about your lecturers, and so forth. By helping to clarify complex academic communications, and allowing input in various forms, the assistant will strive to help students become more efficient, and engaged, with their learning in higher education.

3.2 Specific Objectives

- To design and develop a multi-modal student input processing chatbot for adaptive learning support.
- To add the chatbot to the LMS to provide instant academic information such as registration details, deadlines, module codes, and lecturer contact details.
- To implement explainability features that transform lengthy academic communications, for example, risk notifications and system emails, into student-friendly content.
- To enable personalized academic interventions such as reminders, notifications, and recommendations for at-risk students based on their interactions.
- To enable safe and scalable deployment of the chatbot, maintaining privacy while processing massive amounts of concurrent student requests.

4. METHODOLOGY

4.1 Technologies

Frontend Technologies

React.js: Used to build the chatbot's interactive web interface with a modern and responsive design. Tailwind CSS: Provides a clean and customizable design system, ensuring the UI is user-friendly and scalable.

Backend Technologies

Node.js with Express.js: Handles API services, manages chatbot requests, and integrates with LMS databases. It also ensures scalability for multiple users. Python: Used for machine learning (ML) and natural language processing (NLP) pipelines, powering intent recognition, response generation, and adaptive interventions.

Databases and Data Storage

Firebase Firestore (NoSQL): Stores conversation history, user profiles, logs, and chatbot interactions in real-time. Cloud Storage (Google Cloud / Firebase Storage): Stores large files such as PDFs, lecture recordings, or shared study materials.

AI/NLP Libraries

Hugging Face Transformers: Provides pre-trained models like BERT, GPT, or DistilBERT to understand student queries. TensorFlow / PyTorch: Used for training custom ML models for adaptive interventions and chatbot intent classification.

Speech & Multi-modal Support

Google Speech-to-Text API: Converts student voice queries into text for chatbot processing. Tesseract OCR: Extracts text from images and PDFs (e.g., if a student uploads a screenshot of an email, the chatbot can read and explain it). Text-to-Speech (Google TTS / gTTS): Converts chatbot responses into speech for accessibility.

4.2 System Overview Diagram

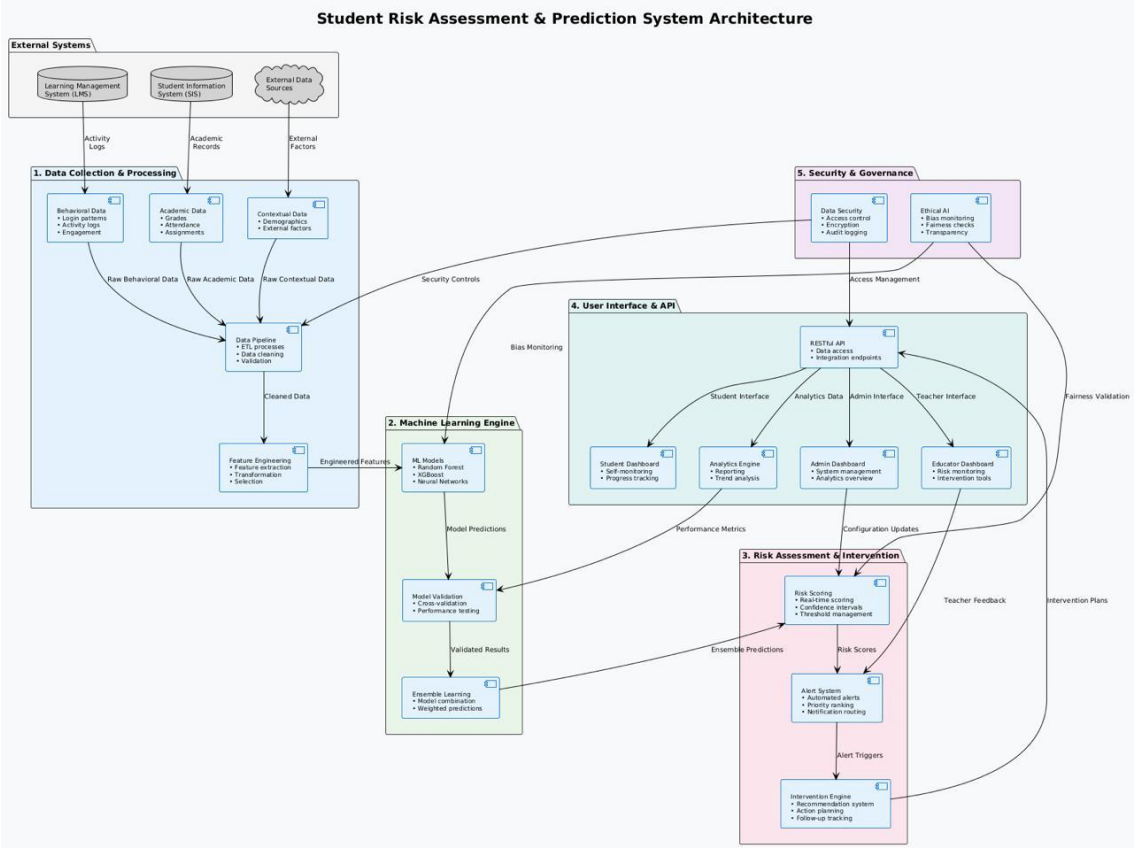
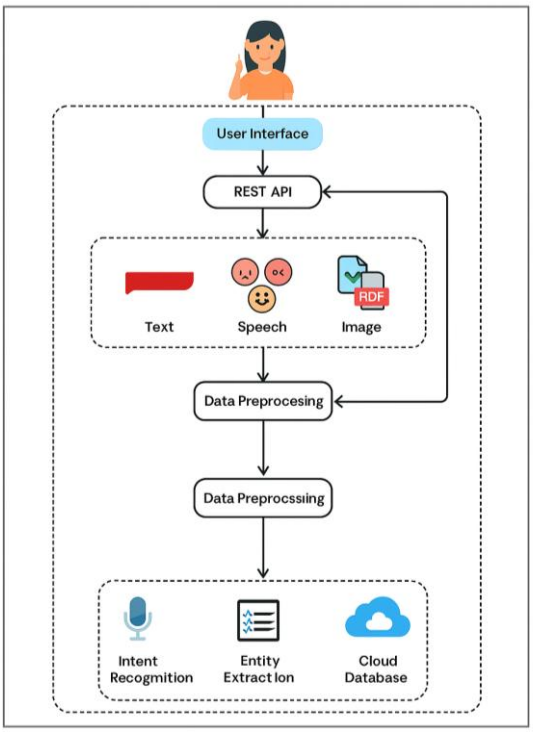


Figure 4.2 System Architecture



4.3 Component Diagram

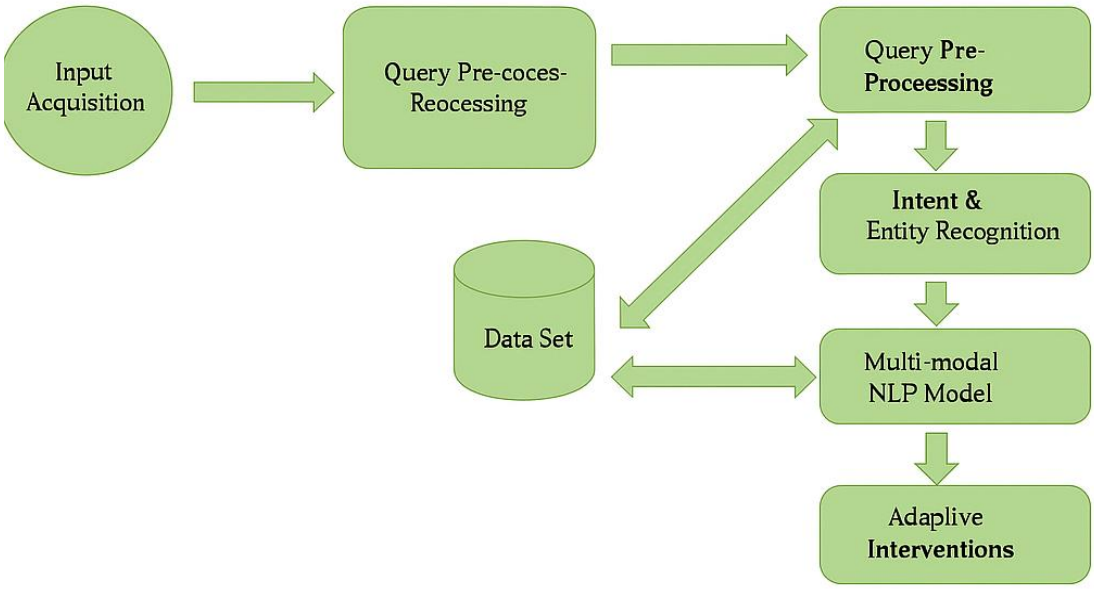


Figure 2 Component Diagram

4.1 Work Breakdown Structure

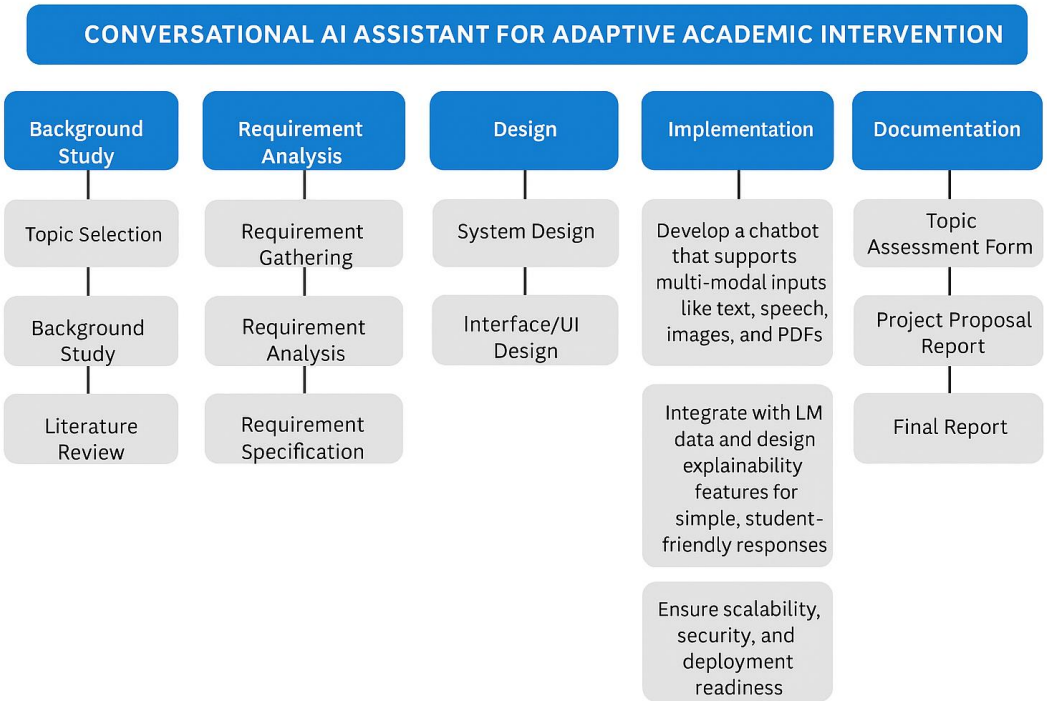


Figure 3 Work Breakdown Structure

5. GANTT CHART

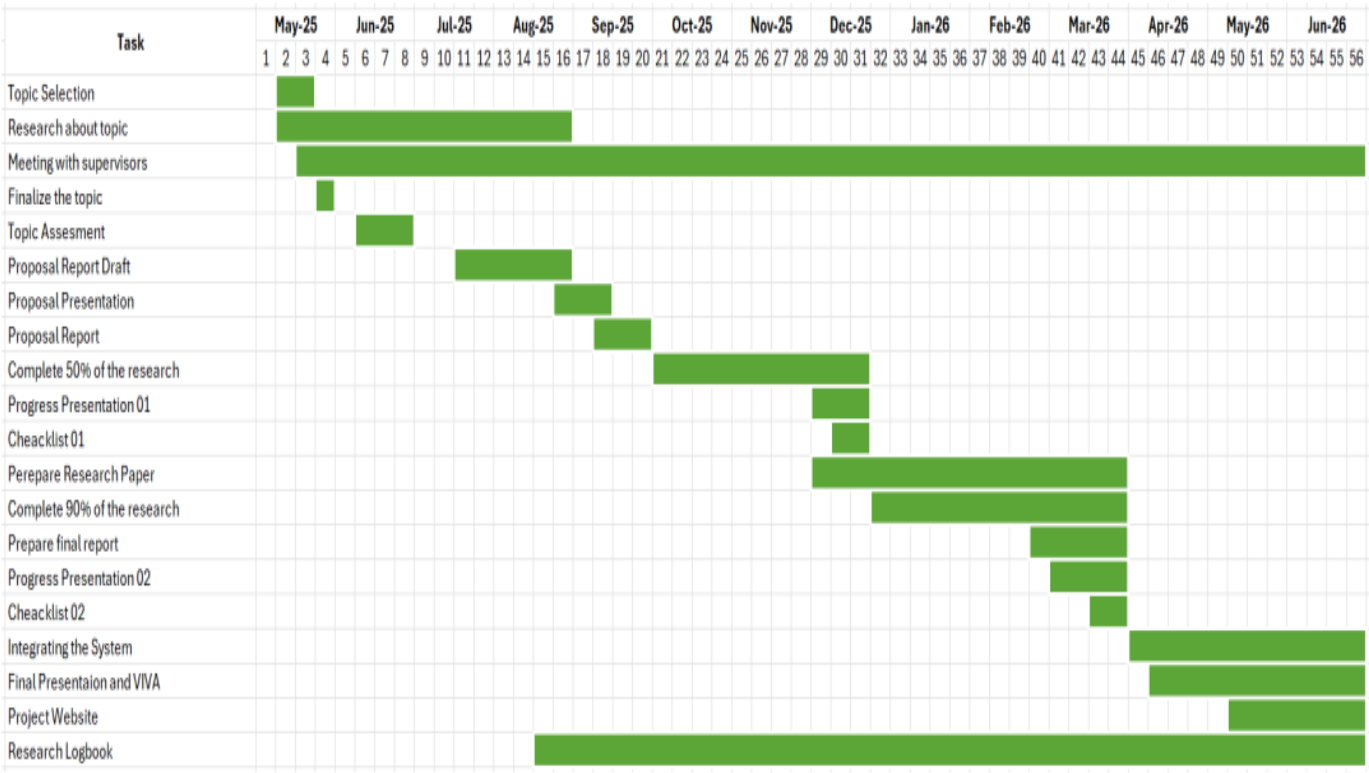


Figure 4 Gantt Chart

6. PROJECT REQUIREMENTS

6.1 Functional Requirements

- The chatbot must accept queries from text, voice, image, and PDF inputs.
- The chatbot must accept real-time academic details (deadlines, module details, lecturer details, payment, recording of lectures) from the LMS.
- The chatbot must provide individualized academic guidance (repeat/prorata registration details, timetables for exams, reminders to pay).
- The chatbot must deconstruct complex academic messages or warning notices into easy-to-understand, student-viewable text.
- The chatbot ought to provide role-specific support.

6.2 User Requirements

- Multi-modal interaction - The system must enable students to engage in the chatbot through text, voice, photos, and PDFs.
- Personalized academic support - The chatbot must provide individual students information on topics such as deadlines for registration, exams, module information, and payment processes.
- Explainability - The chatbot must convert complex academic emails, system notifications, and policies into student-friendly storytelling.
- LMS Integration - The system must integrate with the Youth Learning System (LMS) to fetch real time academic data (modules, lecture content, deadlines, recordings).
- Secure Access - Only authenticated students and lecturers will use the chatbot, ensuring privacy and data protection.

6.3 Expected Test Cases

- Data Integrity Test
  Objective: Verify chat input (text, voice, image, PDF) is transmitted without tampering.
  Expected Result: Manipulated or truncated data is detected and discarded.

- Login Authentication Test
  Objective: Verify that only authorized students can log in to access the chatbot.
  Expected Result: Invalid login attempts, or unauthorized users are disallowed.

- Multi-modal Input Test

Objective: Verify chatbot can successfully process different input types (text, voice, image, PDF).
Expected Result: All types of input are detected, translated, and processed as expected.

- Intent Recognition Accuracy Test

Objective: Test student questions (e.g., deadlines, module codes) are correctly identified by chatbot.
Expected Result: at least 90% accurate intent identification.

- Entity Extraction Test

Objective: Test that entities (module code, lecturer name, payment details) are correctly extracted by chatbot from student input.
Expected Result: Extracted entities are identical to LMS database values.

- Response Accuracy Test

Objective: Ensure that chatbot provides correct and relevant answers according to LMS data.
Expected Result: Answers align with actual deadlines, module data, or academic regulations.

- Email Explanation Test

Objective: Confirm whether chatbot can translate confusing system-generated emails to students.
Expected Result: Chatbot explains emails in an easy-to-understand language for students.

- Performance Test (Response Time)

Objective: Test response time of chatbot for regular and peak loads.
Expected Result: Answers within 2–3 seconds are received.

- Security & Privacy Test

Objective: Safeguard sensitive student information when stored and transmitted.
Expected Result: No data leakage; encrypted information is unreadable if intercepted.

- Scalability Test

Objective: Verify chatbot functionality were hundreds of students converse concurrently.
Expected Result: At least 500+ simultaneous requests are handled without system breakdown.

7. DESCRIPTION OF PERSONAL AND FACILITIES

Registration Number	Name	Description
IT22365750	Nimanji D.L. K	• Collect academic data from the LMS such as module data, deadlines, lecturer information, and registration records. • Prepare and develop datasets consisting of student queries, emails, and documents (text, voice, images, PDFs) to train the chatbot. • Train machine learning models for intent recognition and entity extraction for effective understanding of student queries. • Provide multi-modal support so that the chatbot can process text, voice, images, and PDFs. • Connect the chatbot with the LMS to fetch real-time academic data and reply with customized solutions. • Add explainability features to simplify complex academic emails or system alerts in a step-by-step manner for students. • Create a secure web-based chat window using React.js for easy student interaction. • Use Firebase Firestore for encrypted storage of conversation history and user interactions. • Ensure strong security with JWT authentication and data communication encryption. • Test the system with students and lecturers for accuracy, performance, and usability

Table 3 Description of Personal And Facilities

8. BUDGET AND BUDGET JUSTIFICATION

8.1 Roughly Estimated Budget

Description	Total Amount (Rs.)
Software Licenses & Tools Premium development tools, API testing tools, data visualization packages	12,000
Cloud Services Cloud storage, computing for model training and deployment (AWS/Firebase/Azure) sharing among members	28,000
Internet & Miscellaneous High-speed internet, backup drives, office supplies	5,000
Total Expenses	45,000

Table 4 Roughly Estimated Budget

8.2 Ability Of Commercialization

The suggested Conversational AI Assistant could be monetized as a Software as a Service (SaaS) offering to universities, colleges, and online learning institutions. With the ability to help alleviate administrative workloads, the Conversational AI Assistant can also enhance the student experience by offering timely and personalized academic support. Institutions could subscribe to a license or usage basis and the opportunity for expanding entrepreneurship and scalability could be achieved through premium features like multilingual support, analytics dashboards, and LMS integrations.

9. REFERENCE LIST

[1] L. Labadze, T. Pirveli, and K. Buadze, “Role of AI chatbots in education: a systematic literature review,” *International Journal of Educational Technology in Higher Education*, vol. 20, no. 1, pp. 1–27, 2023.

[2] N. F. Davar, “AI chatbots in education: Challenges and opportunities,” *Information*, vol. 16, no. 3, p. 235, 2025.

[3] M. A. Kuhail, M. Alturki, and M. Al-Samarraie, “Interacting with educational chatbots: A systematic review,” *Education and Information Technologies*, vol. 28, pp. 1417–1444, 2023.

[4] C. W. Okonkwo and A. Ade-Ibijola, “Chatbots applications in education: A systematic review,” *Smart Learning Environments*, vol. 8, no. 1, pp. 1–25, 2021.

[5] J. Chan and Y. Li, “Enhancing higher education with generative AI: A multimodal approach for personalised learning,” *arXiv preprint* arXiv:2502.07401, 2025.

[6] S. Latif, M. Usama, and A. Qadir, “PhysicsAssistant: An LLM-powered interactive learning robot for physics lab investigations,” *arXiv preprint* arXiv:2403.18721, 2024.

[7] S. Winkler and M. Söllner, “Unleashing the potential of chatbots in education: A state-of-the-art analysis,” *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, pp. 1–20, 2021.

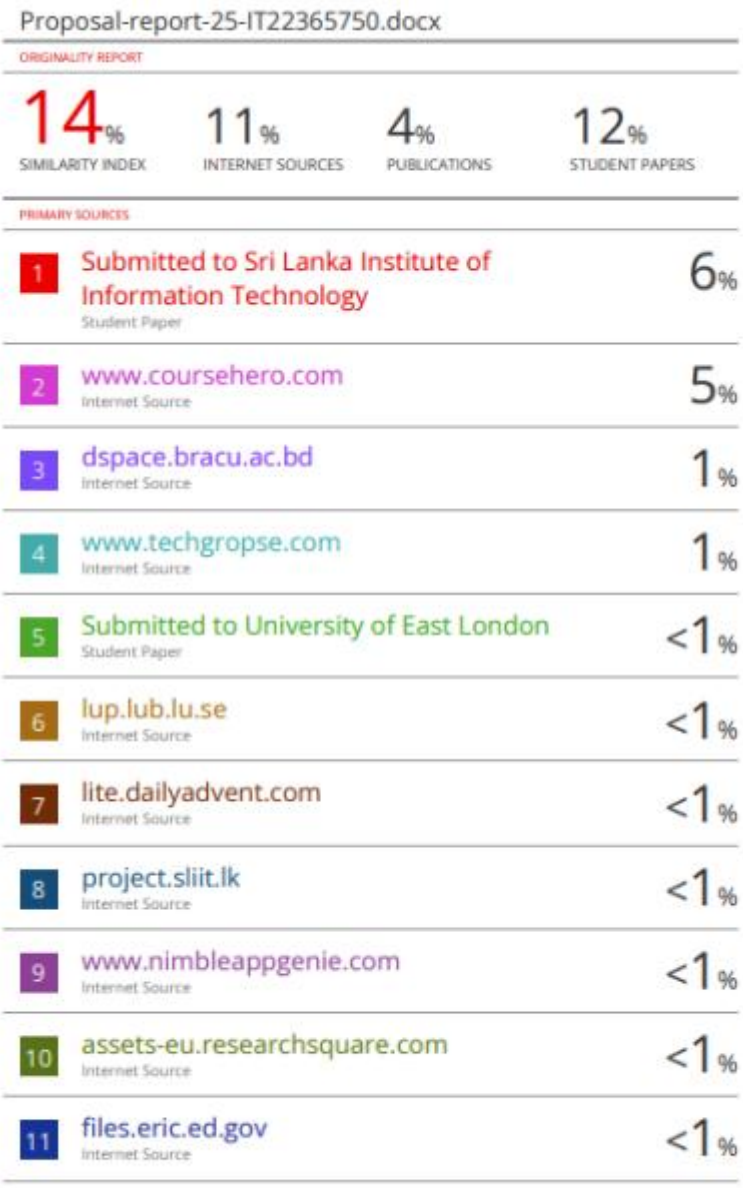
[8] A. Wollny, K. Schneider, and J. L. Seeber, “AI-based conversational agents in higher education: A systematic review,” *Computers and Education: Artificial Intelligence*, vol. 3, p. 100034, 2022.

[9] P. K. Sahu and R. R. Padhy, “Chatbot for education system,” in *2021 2nd International Conference on Advances in Education and Information Technology (AEIT)*, 2021, pp. 90–95.

[10] A. Smutny and P. Schreiberova, “Chatbots for learning: A review of educational chatbots for the Facebook Messenger,” *Computers & Education*, vol. 151, p. 103862, 2020.

10. APPENDICES

10.1 Turnitin Report



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