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DidactAI: Intelligent Learning Insights and Student Assistant

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ABSTRACT: DidactAI is an intelligent learning platform that uses Artificial Intelligence to enhance the way students interact with educational content. Many learners struggle to understand large volumes of complex study material, especially during independent learning. To address this challenge, the system applies Natural Language Processing (NLP) and Machine Learning techniques to analyze and organize educational text. It generates multi-level summaries, including extractive, abstractive, and conceptual summaries, to simplify complex information. Techniques such as Named Entity Recognition and dependency parsing help identify key concepts and relationships within the content.

In addition to summarization, the platform supports learning through automated quiz generation and performance evaluation. The system creates adaptive quizzes that help measure student understanding and reinforce important concepts. Learning analytics are used to monitor progress, identify weak areas, and provide insights for improvement. The platform is implemented using React for the frontend, Flask for backend services, HuggingFace transformer models for NLP processing, and PostgreSQL for data storage. Experimental results indicate that DidactAI improves comprehension, encourages learner engagement, and supports personalized learning experiences.

KEYWORDS: Artificial Intelligence, Natural Language Processing, Adaptive Learning, Multi-Level Summarization, Quiz Generation, Learning Analytics

I. INTRODUCTION

The rapid growth of digital educational resources has significantly expanded access to knowledge. Online platforms, digital textbooks, and open educational materials allow students to learn beyond traditional classroom boundaries. Despite these advantages, many learners find it difficult to process large amounts of information efficiently. Educational content is often lengthy and complex, making it challenging for students to identify key concepts, understand relationships between ideas, and assess their own level of understanding. Traditional learning approaches typically rely on static materials and fixed assessments that do not adapt to individual learning needs.

Recent advances in **Artificial Intelligence (AI)** and **Natural Language Processing (NLP)** have opened new possibilities for intelligent learning systems that can support students during the learning process. AI-based systems are capable of analyzing textual information, extracting important concepts, and generating structured insights that make learning more accessible. Such systems can also provide automated feedback, personalized recommendations, and performance tracking, helping students identify areas that require improvement.

To address these challenges, this paper proposes **DidactAI**, an intelligent learning insights and student assistant designed to enhance digital learning experiences. The system uses NLP-based **multi-level summarization** to transform complex educational materials into simplified summaries that present information in different levels of detail. Extractive, abstractive, and conceptual summaries help learners quickly grasp the main ideas and understand the overall structure of the topic. In addition to summarization, the platform generates **adaptive quizzes** to evaluate student comprehension and provide immediate feedback.

The system also incorporates **learning analytics** to monitor student performance and identify weak concepts that require further study. These insights enable learners to track their progress and adjust their learning strategies

accordingly. The platform is implemented using **React for the frontend, Flask for backend services, HuggingFace transformer models for NLP tasks, and PostgreSQL for data storage.**

II. LITERATURE SURVEY

2.1 Intelligent Learning Systems and Adaptive Education

Research shows that Intelligent Tutoring Systems (ITS) can effectively support student learning by providing guidance similar to human tutors. Studies by researchers such as **K. van Lehn (2011)** highlight how technology-driven tutoring systems improve learning outcomes. Later works expanded this idea by introducing **adaptive learning techniques**, including reinforcement learning and contextual bandits, which personalize educational content based on student performance and behaviour. These approaches help increase engagement, improve completion rates, and provide customized learning pathways for individual learners.

2.2 Natural Language Processing for Educational Content Analysis

Advancements in Natural Language Processing (NLP) and transformer models have significantly enhanced automated educational tools. Models like BART (Lewis et al., 2019) and BERT (Devlin et al., 2020) enable systems to understand context and generate high-quality text summaries. These technologies support applications such as automated summarization, question generation, and semantic analysis. Combined with learning analytics, NLP techniques allow educational platforms to analyse learning patterns, track progress, and automatically generate assessment questions, improving the efficiency and intelligence of modern learning systems.

III. METHODOLOGY

3.1 Student Input Module

The proposed system begins with the student input stage, where the user uploads a document or enters a learning topic into the platform through the interface. This step initiates the personalized learning process by providing the study material that the system will analyse. The user-friendly dashboard allows learners to easily paste text or upload educational documents for processing. Once the input is submitted, the system validates and prepares the content for further analysis. The backend server then receives the input data and forwards it to the AI processing modules. This structured workflow ensures that the educational material is properly organized before further processing. As a result, the platform establishes the foundation for intelligent content analysis and personalized learning support.

3.2 Summarization Module

After receiving the input, the summarization module processes the educational content using advanced Natural Language Processing techniques. The system primarily utilizes the Gemini model to analyse the provided text and generate meaningful summaries. In situations where the primary model is unavailable, the system uses FLAN-T5 as a fallback model to ensure uninterrupted processing. The module generates three different levels of summaries, namely basic, detailed, and overview summaries. These summaries help learners understand the content gradually by presenting simplified explanations of complex topics. The multi-level summarization approach enables students to quickly grasp key concepts without reading lengthy material. By transforming large educational texts into concise insights, the module significantly improves learning efficiency.

3.3 Quiz Generation Module

The quiz generation module focuses on assessing the learner's understanding of the summarized content. This module extracts important keywords, entities, and concepts from the generated summaries using Natural Language Processing techniques. Based on these extracted concepts, the system automatically constructs a set of quiz questions related to the topic. The quiz typically contains fifteen multiple-choice questions that evaluate different levels of conceptual understanding. These questions are categorized into three difficulty levels: easy, medium, and hard. This structured difficulty distribution helps assess both basic knowledge and deeper conceptual understanding. The automated generation of quizzes enables learners to actively engage with the material and test their comprehension.

3.4 Evaluation and Analytics Module

Once the student completes the quiz, the evaluation module analyses the submitted responses and calculates various performance metrics. The system determines the number of correct and incorrect answers and computes the overall

accuracy and score percentage. Learning analytics techniques are applied to interpret the student’s performance and identify patterns in learning behaviour. The module also detects weak concepts where the learner may require additional practice or revision. All quiz attempts, scores, and performance indicators are securely stored in the PostgreSQL database. These stored records allow the system to monitor progress across multiple learning sessions. By providing clear performance insights, the analytics module helps students improve their learning strategies.

3.5 Certification Module

The certification module provides recognition for successful completion of learning assessments within the platform. When a learner achieves a score of 75 percent or higher in the quiz, the system automatically generates a digital certificate. This certificate includes essential details such as the learner’s name, topic title, score, and the date of issue. The certificate acts as an acknowledgment of the learner’s understanding and successful completion of the assessment. It also encourages students to actively participate in learning activities and improve their performance. All certificate information is securely stored within the database for verification and future reference. Users can view and download their certificates directly from the platform dashboard.

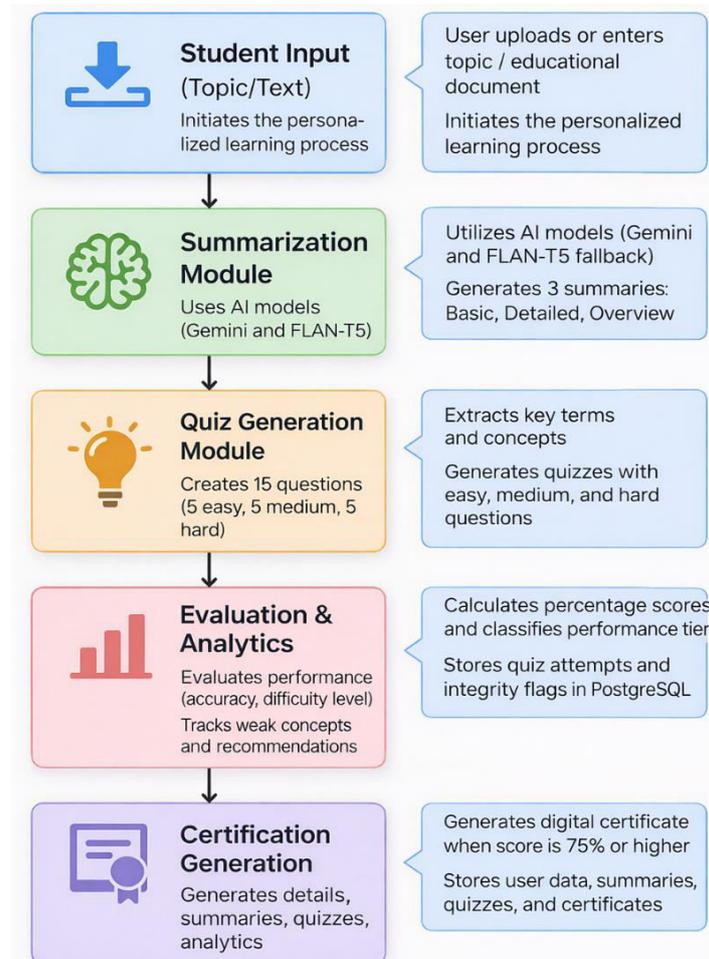


Fig. 1. DidactAI System Methodology

The System Architecture is as follows –

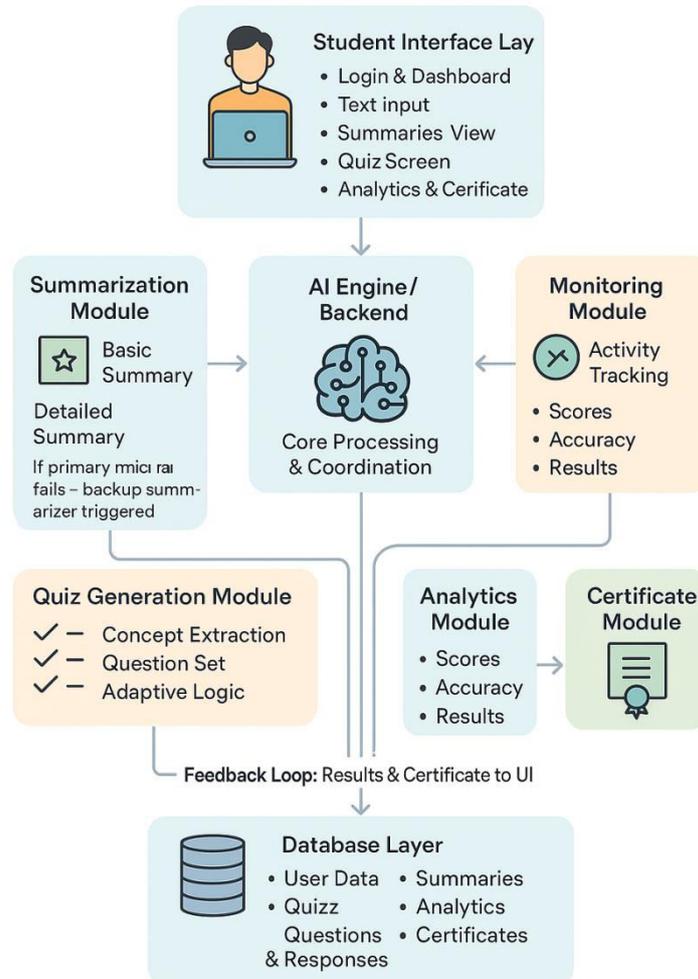


Fig. 2. DidactAI System Architecture

The proposed DidactAI system architecture consists of multiple interconnected modules that work together to support intelligent learning. The Student Interface Layer provides the user dashboard where learners can enter text, view generated summaries, attempt quizzes, and access analytics and certificates. The input content is processed by the AI Engine/Backend, which coordinates the core processing tasks. The Summarization Module generates both basic and detailed summaries of the learning material. The Quiz Generation Module extracts concepts from the text and automatically creates adaptive question sets. The Monitoring and Analytics Modules track learner activity, evaluate quiz performance, and analyse accuracy and results. Finally, all data such as user information, summaries, quiz responses, analytics, and certificates are stored in the Database Layer, while results and certificates are sent back to the user through a feedback loop.

IV. EXPERIMENTAL RESULTS

Fig 3(a) shows the dashboard screen displayed after the user logs into the platform and provides an overview of the system features. It includes modules such as Smart Summaries, Adaptive Quizzes, Learning Analytics, Certificates, and About DidactAI, allowing students to easily navigate the learning environment.



Fig. 3(a). DidactAI System Dashboard.

In this module, the student can upload a document or paste text and select the type of summary required. The system processes the input using AI models and generates summarized content to simplify complex learning materials.

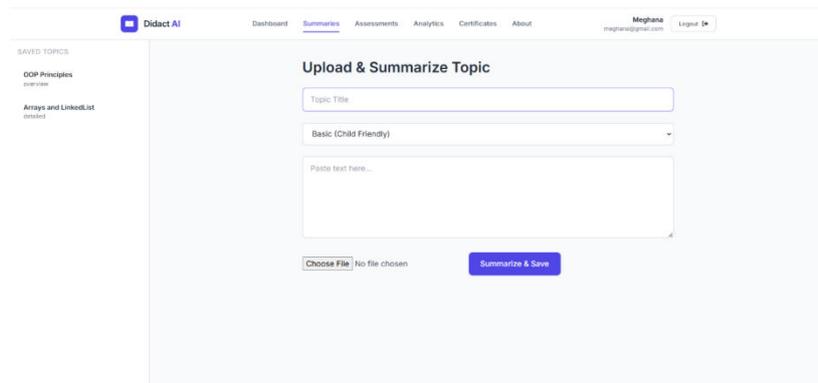


Fig. 3(b). Topic Summarization Module.

After the text is processed by the AI model, the generated summary is displayed to the learner. The summarized output presents the key ideas of the original content in a concise format, allowing students to understand important concepts quickly.

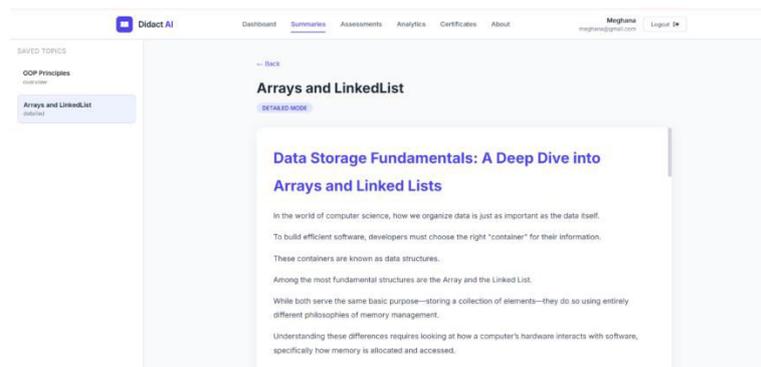


Fig. 3(c). AI Generated Summary View.

This interface allows students to generate quizzes based on the summarized topic. Once a topic is selected, the system automatically creates an assessment containing multiple questions to evaluate the learner's understanding of the material.

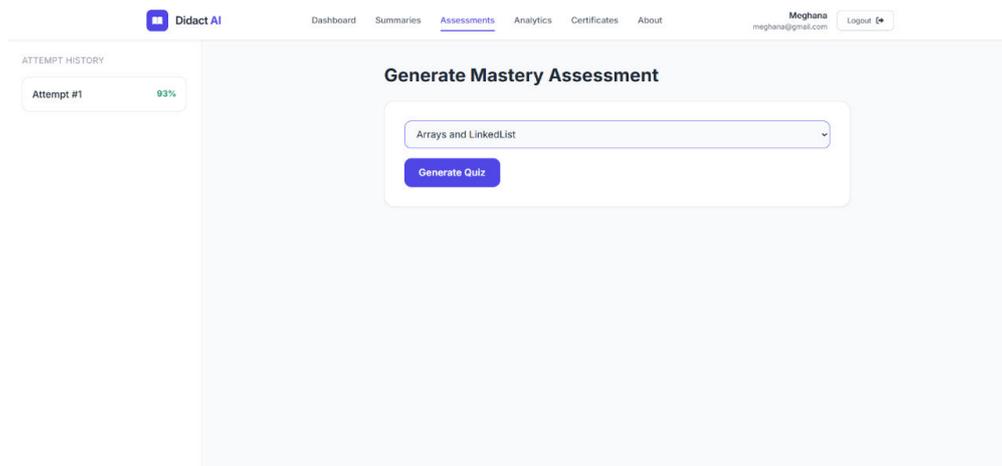


Fig. 4(a). Assessment Generation Module.

The quiz interaction page displays the generated questions along with multiple-choice options. Students can navigate between questions, select their answers, and submit the quiz after completing the assessment.

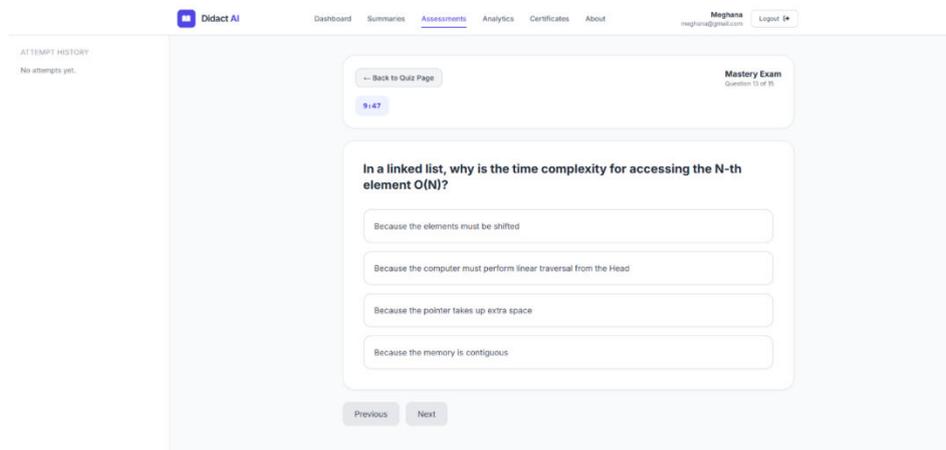


Fig. 4(b). Quiz Interaction Interface.

After submitting the quiz, the system analyses the responses and presents the results. The interface shows the number of correct and incorrect answers and provides feedback to help students understand their mistakes.

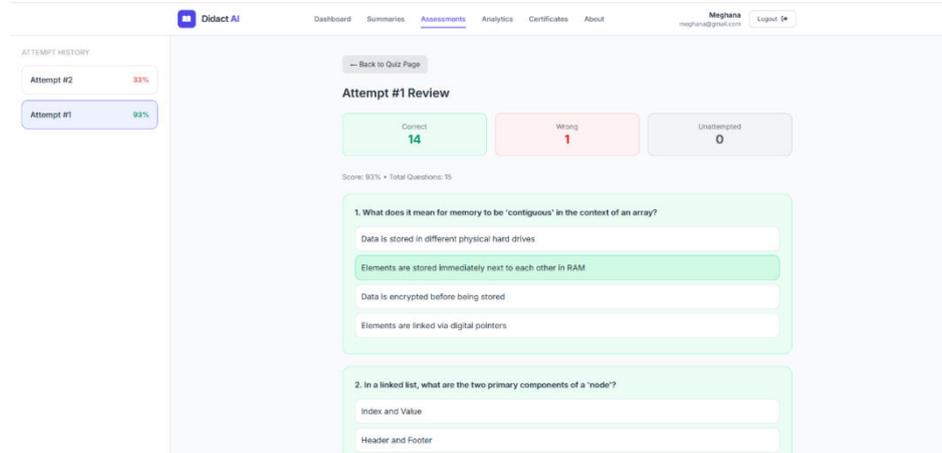


Fig. 4(c). Assessment Result Analysis.

This page provides graphical representations of the learner's performance over time. It includes charts such as mastery progression and difficulty breakdown to help students track their learning progress.

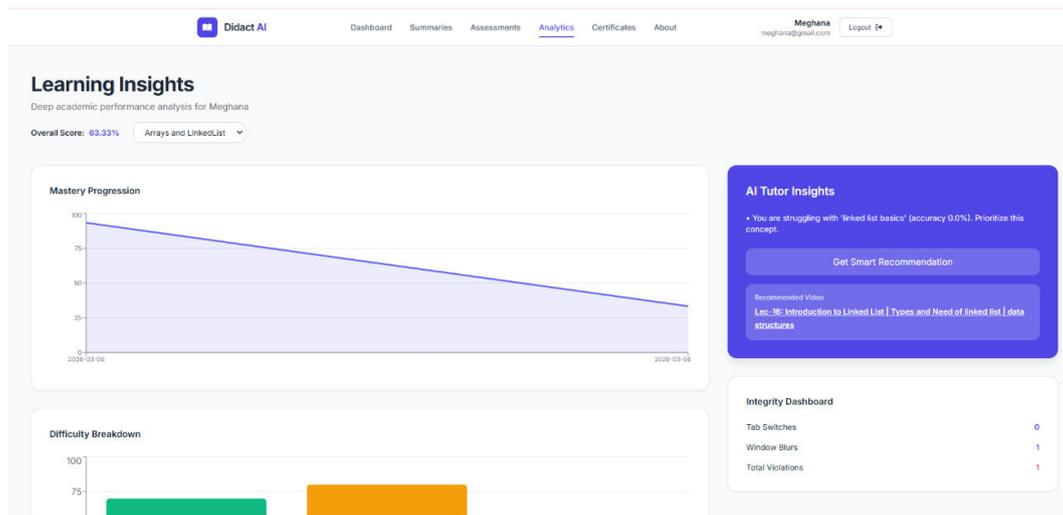


Fig. 5(a). Learning Analytics Visualization.

This module identifies topics where the learner is struggling based on quiz performance. It highlights weak concepts and suggests areas that require additional study and improvement.

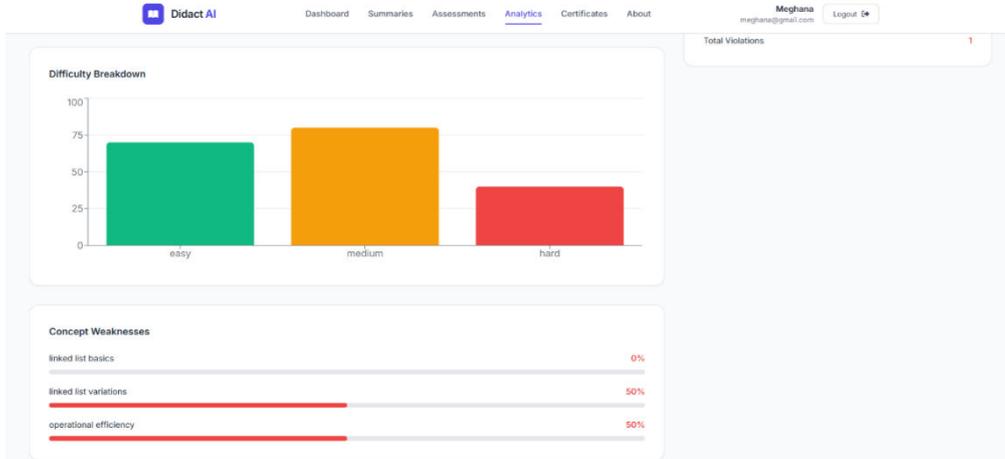


Fig. 5(b). Concept Weakness Analysis.

This module displays the certificates earned by students after achieving the required performance threshold in assessments. The interface allows users to view certificate details such as score, issue date, and certificate ID, and download the certificate for verification.

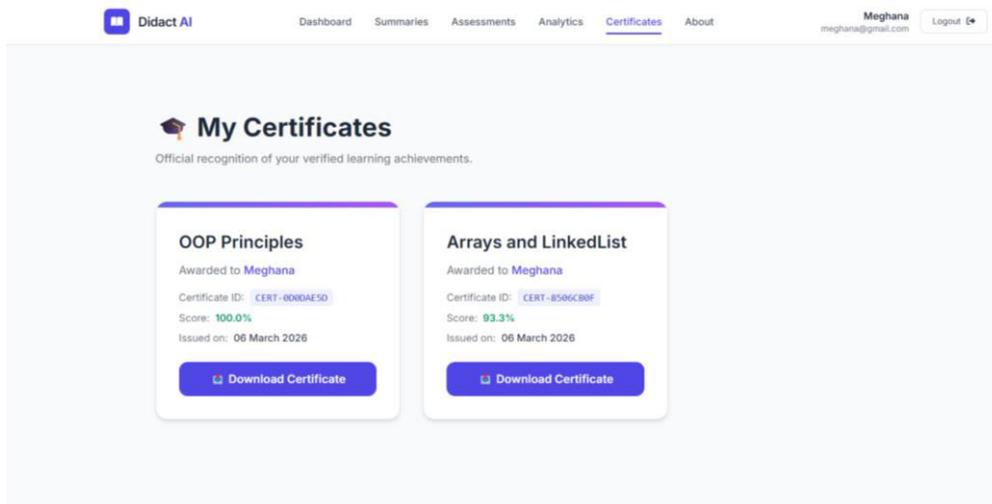


Fig. 6. Certificate Management Module.

V. CONCLUSION

This paper presented **DidactAI**, an intelligent learning platform that integrates Artificial Intelligence and Natural Language Processing techniques to enhance the digital learning experience. The system focuses on simplifying complex educational content by converting lengthy study materials into structured summaries that are easier for students to understand. By providing multiple levels of summarization, learners can explore both basic and detailed explanations of a topic, enabling faster comprehension and more efficient study.

Another important component of the system is the **automated quiz generation module**, which evaluates student understanding based on the summarized content. By extracting key concepts from the learning material, the platform generates questions with varying difficulty levels, including easy, medium, and hard. This structured assessment

approach allows the system to measure conceptual understanding more effectively while encouraging active learner engagement.

The **evaluation and learning analytics modules** further enhance the system by analysing student performance and identifying patterns in learning behaviour. These modules calculate performance metrics such as accuracy, score percentages, and mastery levels. They also highlight weak concepts where students may require additional practice. Through data visualization techniques, the system presents performance insights in an intuitive format, allowing learners to easily track their progress and improve their learning strategies.

DidactAI also maintains a secure database that stores user information, summaries, quiz responses, and analytics data for future reference. In addition, the platform includes a **certification module** that generates digital certificates when learners achieve the required performance threshold. This feature provides recognition for learning achievements and motivates students to actively participate in the learning process.

Overall, the proposed system demonstrates how AI-driven technologies can be effectively integrated into educational platforms to support personalized and data-driven learning. By combining automated summarization, adaptive assessments, learning analytics, and certification features, DidactAI serves as a comprehensive intelligent learning assistant. In future work, the system can be further extended to include advanced adaptive learning strategies, real-time recommendation systems, and deeper personalization mechanisms to further improve student learning outcomes.

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