

Transforming Internal Auditing: Harnessing Retrieval-Augmented Generation Technology

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Abstract—The advent of cloud-based Generative AI models, such as ChatGPT, Google Gemini, and Claude, has created new opportunities for improving education through real-time, adaptive learning experiences. Despite their widespread use globally, their application in South African higher education remains limited and underexplored, resulting in an application gap. This paper, as Phase 1 of a larger project, addresses this gap by focusing on the development of a Retrieval-Augmented Generation (RAG) web application designed to enhance Internal Auditing education at the Durban University of Technology. This is achieved by integrating three powerful Generative AI models—OpenAI GPT-4o-mini, Google Gemini-1.5-flash, and Anthropic Claude-3-haiku—into a single educational platform that will enable lecturers to manage and augment lecture materials while allowing students to access personalized, AI-generated content. This paper presents the design considerations, architecture, and integration techniques employed in the development of the RAG web application, offering insights into the potential of adaptive learning, personalized learning, and AI-driven tutoring in South Africa’s educational landscape. This paper demonstrates how a RAG web application can provide the building blocks for future Generative AI applications that could enhance teaching and learning with minimal effort from lecturers and learners in the South African context.

Keywords—Adaptive learning; Anthropic Haiku; benefits; challenges; Generative AI; Google Gemini API Pro; higher education; internal auditing; OpenAI GPT-Turbo; personalized learning; RAG (Retrieval-Augmented Generation); South Africa

I. INTRODUCTION

This study represents Phase 1 of a broader research initiative. In Phase 1, we focus only on developing the RAG web application—integrating a database with advanced prompting strategies and Generative AI capabilities to support accounting education. Successive phases of this research, namely Phases 2 and 3, are considered for future execution as part of the continuing investigation. Phase 2 will involve piloting the application with Internal Auditing lecturers and students, where the impact of prompt formatting techniques and key model parameters—such as temperature, top_p, and max_tokens—will be examined. During this phase, feedback on the accuracy and relevance of AI-generated outputs will be collected, along with a cost-benefit analysis across OpenAI GPT-3 Turbo, Google Gemini API Pro, and Anthropic Haiku. Phase 3 will compare effectiveness metrics and provide recommendations on the most suitable and cost-effective Generative AI model for educational use.

Since the release of advanced Generative AI models like OpenAI's GPT-3 and GPT-4, Generative AI has rapidly gained prominence across various domains, including education. These AI-powered tools have the potential to revolutionize how knowledge is disseminated, particularly in complex fields such as Internal Auditing. The literature outlines that artificial intelligence (AI) models like OpenAI's GPT-3 Turbo, Google's Gemini API Pro, and Anthropic's Haiku are now being leveraged to enhance educational outcomes by providing real-time, personalized academic support. Studies have demonstrated the effectiveness of these models, with GPT-4, for example, showing superior performance over GPT-3.5 in answering complex questions from the Turkish Medical Specialization Exam, highlighting its potential in medical education [11]. Despite challenges such as the occurrence of false positives and negatives in AI detection tools, the value of Generative AI in education and research continues to be recognized [3]. This study is guided by the following research question: Can a RAG application integrating multiple Generative AI models be developed to support the teaching and learning experience in an Internal Auditing module at a South African university?

Regardless of the transformative potential of AI in higher education, its use in South Africa remains underexplored. Universities are in the early stages of integrating AI-driven solutions, which offer tailored learning experiences and can improve student outcomes. However, significant challenges persist, including the lack of digital infrastructure and insufficient training on AI technologies [8][18]. Furthermore, ethical considerations surrounding AI integration—such as data privacy, the handling of sensitive information, and inherent biases in AI models—complicate its adoption [20]. These concerns are particularly acute when public AI services are used, where the risks of data misuse and compromised privacy are heightened.

These issues become more pressing in an educational context as AI systems interact with sensitive student data, academic performance records and personalized learning pathways. Ensuring that AI systems do not compromise the confidentiality and integrity of this data is essential. Additionally, any cognitive biases embedded in AI models can affect the fairness of assessments, feedback and learning outcomes, which could exacerbate existing educational inequities. Addressing these challenges is critical to ensuring that AI systems are deployed responsibly and equitably in educational settings, safeguarding both student privacy and academic integrity [1],[6],[8],[9],[17].

Regardless of these hurdles, AI has the capacity to enhance educational content delivery, making learning more accessible and personalized. For instance, AI can support adaptive learning environments where students receive individualized instruction based on their performance, helping to bridge educational gaps [8]. Additionally, AI can automate administrative tasks such as grading and feedback, allowing educators to focus more on engaging with students and developing interactive learning experiences. These technologies have the potential to not only reduce the workload of educators but also to significantly enrich student learning through real-time access to global academic resources and dynamic, data-driven insights.

In South Africa, the challenges are compounded by the need for cost-effective and reliable AI solutions that can be scaled across diverse educational settings. This study seeks to fill the gap in research by developing a Retrieval-Augmented Generation (RAG) web application that integrates three leading Generative AI models: OpenAI GPT- Turbo, Google Gemini API Pro, and Anthropic Haiku. This application will be designed to support an Internal Auditing module at the Durban University of Technology, providing real-time, global insights on academic topics.

To address the potential risks associated with AI usage, this study also emphasizes the importance of incorporating advanced prompting techniques, such as Chain of Thought (CoT), Tree of Thought (ToT), and Rephrase and Respond (RaR). These techniques are intended to guide AI models to generate more accurate and contextually relevant outputs, thereby enhancing the reliability of the AI-generated content and ensuring academic trustworthiness.

In the next section, the current literature on Generative AI models in education is reviewed, followed by a discussion of the requirements and design considerations for the RAG web application. Subsequently, the implementation process is detailed, including the integration of advanced prompting techniques and the evaluation of the application's effectiveness. The paper concludes with a discussion of the findings, implications for higher education, and recommendations for future research.

II. GENERATIVE AI RESEARCH

The advent of Generative AI models, particularly in educational settings, has garnered significant attention, with various studies highlighting their potential and challenges. The application of AI in education spans multiple domains, from language learning [8] to tutoring systems [6], each utilizing AI's capabilities to enhance learning outcomes. However, the deployment of AI in specialized fields like Internal Auditing is still emerging. The themes evident from the literature on AI in education discussed in this paper are AI in language learning, Generative AI in higher education and existing AI-powered platforms.

A. AI in Language Learning

Existing research on AI-powered language learning platforms and chatbots demonstrates a wide range of applications [23]. One prominent application is in personalized learning systems, which utilize adaptive algorithms to cater to

individual learners' needs. For example, such systems can dynamically adjust learning content based on students' performance and engagement [12]. This personalized approach has been shown to improve learning outcomes, particularly in language learning environments where learners benefit from real-time feedback and tailored support [8],[14],[19].

Validation tests for AI-driven educational platforms, such as those used in language learning, have shown significant improvements in training accuracy and reduced error rates [5]. Specifically, these reduced error rates refer to the system's ability to produce more accurate responses compared to human-provided answers. In this context, "error rates" represent the frequency of incorrect responses generated by the AI during assessments. As the system refines its models over time, adapting to the learning data, it becomes more precise, reducing the occurrence of mistakes and improving overall reliability in real-world applications [5].

B. Generative AI in Higher Education

While the use of AI in language learning is well-documented, its application in higher education, particularly in specialized fields like Internal Auditing, remains underexplored. Studies have shown that Generative AI models like GPT-3 and GPT-4 significantly enrich learning by offering real-time, personalized academic support [8]. However, the adoption of such technologies in South Africa's higher education system is still in its infancy. For example, AI integration in legal education has improved student engagement, with learners achieving faster grade improvements by utilizing AI tools to tackle complex topics such as case analysis [4],[15]. Furthermore, the integration of AI in journalism education is also being explored. AI has the potential to improve productivity in news production, leading to curriculum adaptations to incorporate AI usage, ethical considerations and its applications in modern newsrooms [13].

The introduction of newer Generative AI models like OpenAI GPT-4, Google Gemini, and Anthropic Claude has expanded the potential of AI in educational environments. OpenAI GPT-4, widely recognized for its application in autodidactic learning, supports self-directed learners by providing personalized guidance, real-time feedback, and interactive assistance [7]. Anthropic Claude, with its focus on ethical AI, has shown promising results in educational applications. For example, Claude was tested alongside GPT models in creating virtual patients for medical education, offering scalable and low-cost simulations that improve clinical reasoning and decision-making skills [2]. Claude's design emphasizes transparency, ethical deployment, and minimizing harmful biases, making it a reliable tool for equitable educational environments. These attributes, alongside its role in AI governance and accountability, make Claude particularly well-suited for educational institutions prioritizing responsible AI deployment [21].

Google Gemini, a multimodal AI system, has demonstrated significant advancements in real-time processing of diverse data types such as text, images, audio, and video, making it particularly suitable for dynamic, multidisciplinary academic environments. Its unique mixture-of-experts architecture allows for highly efficient processing, enabling greater scalability and

adaptability in educational applications, especially in fields like law, science and healthcare, where handling multimodal information is crucial [16]. These capabilities position Gemini as a capable tool for providing enriched, interactive learning experiences in higher education.

C. Existing AI-Powered Platforms

Several AI-powered platforms have been developed for language learning, such as Duolingo and Cleverbot, focusing primarily on vocabulary and grammar drills. Duolingo, which utilizes gamification and adaptive learning techniques, enables learners to manage their pace and content through structured modules but often lacks the depth needed for more specialized fields like Internal Auditing [10]. Similarly, Cleverbot, a chatbot-based platform, engages users in conversational exchanges by learning from past interactions. However, its primary strength lies in mimicking human conversation rather than offering adaptive or context-aware learning experiences that could evolve based on the user's subject matter expertise [22]. In contrast, the proposed RAG-based system in this study aims to address these limitations by offering tailored academic support for Internal Auditing, providing specialized and personalized learning paths for students at the Durban University of Technology at the directive of the lecturer and in line with the module outcomes.

This study builds on the existing body of research by exploring the application of Generative AI models in a new context, higher education in South Africa, specifically within the Internal Auditing module. By leveraging the strengths of OpenAI GPT-4-mini, Claude-3-haiku-20240307, and Google Gemini-1.5-flash, this study aims to develop a RAG web application that not only enhances learning outcomes but also addresses the unique challenges faced by educational institutions in South Africa.

III. RESEARCH METHODOLOGY

This section details the methodology employed in the development of a RAG web application designed to enhance the learning experience for students in an Internal Auditing module at the Durban University of Technology. The methodology integrates multiple cutting-edge Generative AI models into a Python Flask web application, supported by SQLite for data management. The process follows a structured approach to ensure the application is functional, scalable, and suited to the educational context. Fig. 1 provides a visual representation of the workflow, showing the interaction between lecturers, students, AI models, and the SQL database. Lecturers create and manage lecture content, while students access both lecture content and AI-generated materials. The flow of data between the users, AI models, and the database supports dynamic and personalized learning experiences.

A. Web Application Development with Python Flask

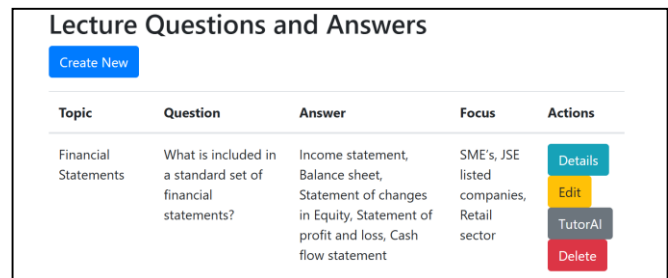
The web application was developed using Python Flask, a lightweight framework ideal for the pilot of our educational application that requires real-time user interaction.

1) *Authentication and user management:* The authentication system supports login, signup, and logout functionalities with role-based access control. During the signup process, users are assigned roles: lecturer or student. Lecturers use the system to manage lecture content, while students access lecturer and AI-generated materials.

2) *Lecture management:* Lecturers can create, edit, and manage lecture questions and answers through a set of web forms. This content is stored in an SQLite database, ensuring that all data is securely saved and retrievable for AI-driven content generation.

Fig. 2 illustrates the list view of the Lecture Management interface, where lecturers can view all previously created lecture questions. The list includes columns for the topic, question, answer, and focus, along with action buttons to view details, edit, or delete content. The TutorAI button allows lecturers to invoke AI to generate content based on existing questions and answers. This streamlined interface helps lecturers keep track of lecture materials and manage them efficiently.

Fig. 3 illustrates the creation form where lecturers can add new lecturer questions. The form includes fields for entering the overarching lecture topic, desired question, expected answer, and focus area (industry, local, global, etc.), allowing lecturers to define the specific content they wish to include in their lecture. Once submitted, the new question is added to the list, as seen in Fig. 2, where it can be managed further through the available actions.



The screenshot shows a web interface titled "Lecture Questions and Answers". At the top left is a blue "Create New" button. Below it is a table with the following columns: Topic, Question, Answer, Focus, and Actions. The table contains one row of data. The Actions column for this row contains four buttons: "Details" (blue), "Edit" (yellow), "TutorAI" (grey), and "Delete" (red).

Topic	Question	Answer	Focus	Actions
Financial Statements	What is included in a standard set of financial statements?	Income statement, Balance sheet, Statement of changes in Equity, Statement of profit and loss, Cash flow statement	SME's, JSE listed companies, Retail sector	Details Edit TutorAI Delete

Fig. 1. Lecture management - List view (add, edit, delete questions and answers).

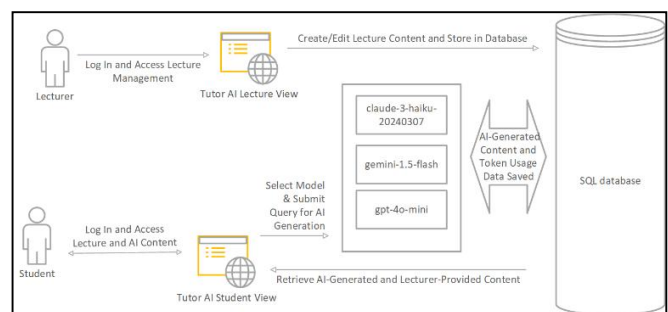


Fig. 2. Application flow.

Fig. 3. Lecture management: Create lecture question and answer screen.

B. Integration of Generative AI Models

The RAG web application integrates three Generative AI models to provide students with dynamic and personalized educational content based on the lecturer-provided lecture questions. This functionality allows students to enhance their understanding by accessing AI-generated answers and examples directly aligned with their course materials.

TutorAI List Generated Based on this Lecture Question:
What is included in a standard set of financial statements?

Generate with OpenAI Generate with Claude Generate with Gemini

Generated Question	Generated Answer	Model Used	Input Token	Output Token	Actions
How do financial statements support decision-making for SMEs in the retail sector?	Financial statements provide SMEs in the retail sector with valuable insights into their financial health, including revenue trends, profitability, and cash flow management. By analyzing the income statement, SMEs can assess sales performance and manage costs, while the balance sheet offers a snapshot of assets, liabilities, and equity to evaluate financial stability. The cash flow statement reveals the liquidity position, helping businesses forecast cash needs and make informed investment decisions. Overall, these statements enable effective budgeting, strategic planning, and performance evaluation, which are crucial for sustaining growth in a competitive retail environment.	OpenAI	100	127	Details Copy Delete
What are the key components of a standard set of financial statements for JSE-listed companies in the retail sector?	A standard set of financial statements for JSE-listed companies in the retail sector typically includes: 1. Income Statement: This statement shows the company's revenue, expenses, and net profit or loss over a specific period, usually a year or a quarter. 2. Balance Sheet: This statement provides a snapshot of the company's assets, liabilities, and shareholders' equity at a specific point in time. 3. Statement of Changes in Equity: This statement outlines the changes in the company's shareholders' equity, including any new share issues, dividends paid, and net income or loss. 4. Statement of Cash Flows: This statement shows the movement of cash in and out of the business, categorized into operating, investing, and financing activities. 5. Notes to the Financial Statements: These provide additional details and explanations to support the information presented in the primary financial statements, such as accounting policies, segment information, and related-party transactions. These financial statements help JSE-listed retail companies and investors analyze the company's financial performance, liquidity, and overall financial health, which is crucial for informed decision-making.	Claude	129	267	Details Copy Delete
## How do the financial	While both SMEs and JSE-listed companies in the retail sector will present the same core financial statements (Income Statement, Balance Sheet, Statement of Changes in	Gemini	144	383	Details Copy

Fig. 4. TutorAI integration of Generative AI models for students.

Fig. 4 illustrates how students can interact with the TutorAI system by generating additional questions and answers related to their lecture materials. Students have the option to select from three AI models, 1) OpenAI GPT-4o-mini, 2) Anthropic Claude-3-haiku, and 3) Google Gemini-1.5-flash, based on their content needs.

1) *OpenAI GPT-4o-mini*: This model generates in-depth answers and explanations related to the lecture material. When a student clicks "Generate with OpenAI," the model processes the lecture question and returns detailed responses. The input and output tokens (reflecting the number of tokens used for generating content) are tracked to monitor how much content is generated for each query.

2) *Anthropic Claude-3-haiku-20240307*: Students can select this model for more creative and comprehensive explanations. By choosing "Generate with Claude," students receive answers that delve into broader interpretations or

applications of their lecture content, which helps deepen their understanding.

3) *Google Gemini-1.5-flash*: This model is ideal for concise, fact-based content. When students click "Generate with Gemini," they get brief, straightforward answers, which are useful for summarizing or revisiting key lecture concepts. Token usage data is also tracked here.

The generated content is displayed in a structured table, which includes the question, the AI-generated answer, the model used, and token usage statistics. Students can also view more details and edit or delete the generated content, providing them with flexibility in managing the information they receive.

By offering these AI models, the system empowers students to explore multiple perspectives and explanations on lecture topics, enhancing their learning experience through AI-generated content that is tailored to their academic needs.

C. Data Management with SQLite

SQLite is used for data storage, providing a secure and scalable solution for managing user data, lecture materials, and AI-generated content. Data management for this study is discussed under database configuration, data security, and token usage tracking.

1) *Database configuration*: The SQLite database serves as the primary repository for lecture content, user data, and AI-generated responses. A structured database schema ensures easy retrieval of data for both lecturers and students.

2) *Data security*: The application employs secure connection strings to SQLite, with strict role-based access control to protect sensitive data.

3) *Token usage tracking*: In order to manage the costs of using external AI APIs, the system tracks token usage (input and output) for each AI model. This data is stored in the database to monitor efficiency and manage costs.

D. Workflow and System Architecture

The architecture supports seamless interaction between users, AI models, and the database. User interaction, AI content generation, and response delivery are considered at this stage.

1) *User interaction*: Lecturers and students interact with the system through web interfaces: Lecturers manage lecture content and students access AI-generated content. These interfaces are user-friendly and responsive.

2) *AI Content generation*: When a user submits a query, the system constructs a prompt using stored lecture data and sends it to the selected AI model. The AI model generates content, which is stored in the database for future access.

3) *Response delivery*: The generated content is then delivered to the user in a formatted and accessible manner, providing real-time feedback and enhancing the learning experience.

E. Implementation Challenges and Solutions

Several challenges were encountered during development and are summarized under model integration, data privacy, scalability and cost management.

1) *Model integration*: Managing multiple AI models requires careful handling of API keys and response formats. Standardized prompts and consistent response parsing were implemented to ensure coherence across models.

2) *Data privacy*: Protecting user data was a top priority. The system uses encrypted connections to SQLite and strict access control to safeguard sensitive information.

3) *Scalability and cost management*: By tracking token usage across the AI models, the system monitors API efficiency and manages costs, ensuring scalability as user activity grows.

IV. FINDINGS AND IMPLICATIONS FOR HIGHER EDUCATION

The development of the RAG web application demonstrates the successful integration of multiple Generative AI models to enhance the educational experience for students in an Internal Auditing module at the Durban University of Technology. By leveraging cutting-edge AI models, OpenAI GPT-4o-mini, Google Gemini-1.5-flash, and Anthropic Claude-3-haiku, the application provides dynamic, personalized content to support both lecturers and students.

Lecturers can efficiently manage their lecture materials, create and update content, and utilize AI-generated enhancements to enrich their teaching. Meanwhile, students are empowered with tailored AI-generated responses, offering multiple perspectives and deeper insights into the course material. The system architecture, built on Python Flask and supported by Azure SQL, ensures that the platform is scalable, secure, and cost-effective, addressing the specific needs of the academic environment.

The integration of role-based access control, seamless data management, and AI-driven content generation allows for an interactive and flexible learning experience. As AI technologies continue to evolve, this application sets the stage for further innovations in educational tools, offering a model for how institutions can harness the power of AI to improve academic outcomes.

V. CONCLUSION

The RAG web application not only integrates multiple Generative AI models to support the teaching and learning experience but also provides a blueprint for future applications of AI in higher education, transforming traditional learning methods into more interactive and personalized experiences. Higher education institutions can leverage the RAG web application to drive and support more effective and real-world student solutions.

Although the development of the RAG shows promise, the accuracy and relevance of the Generative AI outputs necessitate further research to be performed on the implementation of the application. As Phase 2 of a broader research initiative, this needs to be done through a pilot study. During this phase, feedback on the accuracy and relevance of AI-generated outputs will be collected, along with a cost-benefit analysis across OpenAI GPT-3 Turbo, Google Gemini API Pro, and Anthropic Haiku.

Given the use of AI applications and the associated costs, a cost-benefit analysis must be carried out. Phase 3 of a broader research initiative will entail the comparison of costs, relevance and accuracy associated with OpenAI GPT-3 Turbo, Google Gemini API Pro, and Anthropic Haiku. The most cost-effective and accurate Generative AI model for educational purposes among the three AI platforms will need to be determined. This will entail the analysis of the feedback and cost data collected. Researchers and developers can warrant the responsible, positive and cost-effective disposition of a RAG web application in various disciplines at a higher education setting while shielding against likely risks.

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