

Research Papers/Extended Abstract

Enhancing Quality Assurance in Medical Education Using Artificial Intelligence-Based Personalised Student Feedback System: ‘Sisu Athwala’

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Abstract

Mentoring and feedback play crucial roles in medical education, addressing various issues including exam performance, study techniques, stress management and personal preferences and is an integral component of quality assurance in medical education. However, time constraints and limited human resources pose significant challenges in providing personalised guidance to students. This study aimed to explore the utility of an AI-based personalised feedback system in addressing the needs of medical students at the University of Peradeniya, Sri Lanka. The study was conducted at the Department of Pharmacology. Students provided self-evaluations including previous exam results, study techniques, and stress coping strategies. An AI system, powered by GPT-4 large language model using a retrieval augmented generation pipeline, engaged in conversations with students, systematically addressing each point. The AI's responses were grounded on a curated database of existing literature on feedback. Expert human student counsellors evaluated the system's performance across multiple domains, including its ability to address key points, provide insightful suggestions, offer sufficient details, personalise feedback, use varied language expressions and introduce novel perspectives. Evaluator responses were largely positive. All evaluators agreed that the system effectively addressed key points of students' strengths in study performance, clearly identified weaknesses and offered insightful and novel suggestions for improvement. The majority of evaluators (70-90%) agreed that the system provided clear guidance on exam preparation, offered sufficient detail to guide effective study techniques and personalised feedback to address individual needs. Eighty percent of evaluators agreed that the system utilised varied language and expressions effectively. The AI-based personalised feedback system- ‘Sisu Athwala’ demonstrated promising results in providing comprehensive, tailored guidance to medical students. This approach shows potential in addressing the resource constraints faced by educational institutions while maintaining high-quality, personalised student support. Though not a replacement for human counsellors, this AI system could serve as a valuable complementary tool in medical education, enhancing the accessibility and consistency of student feedback and, also offers a scalable solution to enhance mentoring efforts, contributing to overall quality assurance in medical education.

Keywords: *Artificial Intelligence, Medical Education, Personalized Student Feedback System, Quality Assurance*

Introduction

The landscape of medical education is rapidly evolving, driven by advancements in technology and the increasing complexity of healthcare delivery. As medical students navigate their educational journeys, they face numerous challenges, including mastering vast amounts of information, performing well on assessments, managing stress and developing effective study techniques (Abdulghani et al., 2011). Traditional methods of feedback and counselling often fall short in addressing the diverse needs of students, leading to a demand for innovative solutions that can provide personalised support. In this context, artificial intelligence (AI) has emerged as a promising tool to enhance the educational experience and outcomes for medical students (*A Blueprint for Using AI in Psychotherapy*, 2023; Patil & Rasave, 2021). This paper presents the development and implementation of an AI-assisted system designed to provide tailored feedback to medical students, focusing on key areas such as Multiple-Choice Question (MCQ) and Short Answer Question (SAQ) performance, stress management and optimal study strategies.

Objective

This study was aimed, to design and implement an AI-assisted system using Retrieval Augmented Generation (RAG) to provide customised feedback to medical students at the University of Peradeniya, to address individual student performance, stress management, and study strategies; to assess the effectiveness of the AI system in improving students' performance on MCQs and SAQs; to ensure that the feedback is relevant and addresses specific areas of difficulty; to evaluate the effectiveness of the feedback system to effectively address key points of students' strengths in study performance, identify weaknesses and offer insightful and to offer novel suggestions for improvement.

Methodology

This study was conducted at the Department of Pharmacology, University of Peradeniya. Students provided self-evaluations including previous exam results, study techniques, and stress coping strategies.

The core components of this system include a Large Language Model (LLM), which is accessed through an application programming interface. LLMs, designed to process and generate human-like text, are foundational for interpreting user inputs and generating contextually relevant responses. To support efficient and relevant information retrieval, the system employs an embedding model. The embedding model transforms text data into high-dimensional numerical representations known as vectors, capturing the semantic essence of the content. These vectorized representations are then stored in a specialised vector database, which allows for the efficient querying and retrieval of relevant information based on cosine similarity for fast and accurate responses during real-time interactions. Additionally, open-source orchestration libraries are utilised to integrate these components seamlessly.

In the design of the RAG pipeline, experts in the medical education field developed a structured instruction set focusing on improving MCQ marks, SAQ marks, stress reduction methods and optimal study techniques.

To generate user queries, students were provided with a structured questionnaire to gather information about their concerns regarding MCQ marks, SAQ marks, stress level and study techniques.

The responses from this questionnaire were processed using a technique known as Representative Vector Summarization (RVS). It is a method that condenses the most salient points of the collected responses into a smaller set of representative vectors. By summarising the key information in this way, the system ensures that the most critical concerns of each student are distilled and captured accurately, minimising noise or irrelevant details. This user query was processed using the Open AI Application Programming Interface (API), specifically utilising the GPT-4-turbo LLM. The AI-generated outcome underwent post-processing to structure and refine the response, ensuring clarity and relevance.

Students were invited to use the newly developed ‘Sisu- Athwala’ tool. Volunteered students were given the chance to chat with the tool at their own pace inquiring into their strengths, weaknesses and plans for enhancing performance.

To evaluate the output of the tool, expert human student counsellors assessed the quality of the responses across several key metrics. These included the system’s ability to address the primary concerns outlined in the query, offer insightful and actionable suggestions, provide sufficient depth and detail in the feedback, and to personalise the response to each student’s unique situation. Additional metrics of evaluation included the diversity of language expressions used in the AI responses and the system’s ability to introduce novel perspectives or recommendations that went beyond generic advice. The feedback from these evaluations informed iterative improvements to both the prompt design and post-processing steps.

Results

During the design and development of the feedback system, significant new insights were gained, particularly in optimising how the AI-generated responses could be made more personalised and relevant to each student's concerns. One of the key learning was the importance of refining the prompt templates and embedding techniques to capture details from student queries.

The output of the 'Sisu-Athwala' tool was promising was on par with the Pendleton model of feedback. Sisu-Athwala always made sure to involve the student equally in the discussion instead of giving ideas alone. By prompting open ended questions, AI tool motivated the students to express their ideas freely.

In each step of discussion, the AI tool tried to address a certain issue at a time and then move to the next issue. Therefore, it gave only a small chunk of information at a time. This is a very good characteristic of an AI tool which makes the student more engaged in the feedback session.

Whenever AI is suggesting an option during the discussion, it gave clear examples which can be easily understood. Also specific remedial options were given following identifying defects. When suggesting to engage in an activity, it gave clear sources that can be used to achieve that particular task.

Evaluations by the human student counsellors were largely positive. All evaluators (100%) agreed that the system effectively addressed key points of students' strengths in study performance, clearly identified weaknesses, and offered insightful and novel suggestions for improvement. The majority of evaluators (70-90%) agreed that the system provided clear guidance on exam preparation, offered sufficient detail to guide effective study techniques, and personalised feedback to address individual needs. An 80% of evaluators agreed that the system utilised varied language and expressions effectively.

Discussion

Several studies have explored the use of AI in educational settings. For instance, AI-driven tutoring systems have been developed to assist students in various subjects, including mathematics and language learning (Baumgart & Mamlouk, 2022; Koedinger et al., 2013). These systems typically employ rule-based algorithms or machine learning models to provide personalised instruction and feedback. Despite these advancements, existing AI systems in medical education often face limitations. Many rely on pre-defined rules and lack the flexibility to adapt to individual student needs (Miner et al., 2019). Additionally, the feedback provided is sometimes generic and not sufficiently tailored to address specific areas of improvement. Furthermore, these systems may not adequately

address the psychological aspects of learning, such as stress management and study techniques, which are crucial for medical students (Muhammad, 2023).

Traditional AI tutoring systems often provide one-size-fits-all feedback, failing to account for the unique learning needs and preferences of individual students. Many existing systems focus primarily on cognitive skills, neglecting the affective and metacognitive aspects of learning, such as stress management and effective study strategies. Rule-based systems can be rigid, offering static feedback that may not evolve with the student's progress or changing needs. The feedback provided by traditional methods can be delayed, reducing its effectiveness in facilitating immediate learning and improvement. The AI-based personalised feedback system- 'Sisu Athwala' demonstrated promising results in providing comprehensive, tailored guidance to medical students. This approach shows potential in addressing the resource constraints faced by educational institutions while maintaining high-quality, personalized student support. Though not a replacement for human counsellors, this AI system could serve as a valuable complementary tool in medical education, enhancing the accessibility and consistency of student feedback and also offers a scalable solution to enhance mentoring efforts, contributing to overall quality assurance in medical education.

Conclusion

The AI-based personalised feedback system- 'Sisu Athwala' demonstrated promising results in providing comprehensive, tailored guidance to medical students. This approach shows potential in addressing the resource constraints faced by educational institutions while maintaining high-quality, personalised student support. Though not a replacement for human counsellors, this AI system could serve as a valuable complementary tool in medical education, enhancing the accessibility and consistency of student feedback and also offers a scalable solution to enhance mentoring efforts, contributing to overall quality assurance in medical education.

References

- A Blueprint for Using AI in Psychotherapy. (2023, June 21). *Stanford HAI*. <https://hai.stanford.edu/news/blueprint-using-ai-psychotherapy>
- Abdulghani, H. M., AlKanhal, A. A., Mahmoud, E. S., Ponnampuruma, G. G., & Alfaris, E. A. (2011). Stress and its effects on medical students: A cross-sectional study at a college of medicine in Saudi Arabia. *Journal of Health, Population, and Nutrition*, 29(5), 516-522.
- Baumgart, A., & Madany Mamlouk, A. (2022). A knowledge model for AI-driven tutoring systems. In *Information Modelling and Knowledge Bases XXXIII* (pp. 1-18). IOS Press. <https://doi.org/10.3233/FAIA210474>

- Koedinger, K. R., Brunskill, E., Baker, R. S. J. d, McLaughlin, E. A., & Stamper, J. (2013). New potentials for data-driven intelligent tutoring system development and optimization. *AI Magazine*, 34(3), Article 3. <https://doi.org/10.1609/aimag.v34i3.2484>
- Miner, A. S., Shah, N., Bullock, K. D., Arnow, B. A., Bailenson, J., & Hancock, J. (2019). Key considerations for incorporating conversational AI in psychotherapy. *Frontiers in Psychiatry*, 10. <https://doi.org/10.3389/fpsyt.2019.00746>
- Muhammad, R. (2023). Barriers and effectiveness to counselling careers with artificial intelligence: A systematic literature review. *Ricerche Di Pedagogia e Didattica. Journal of Theories and Research in Education*, 18(3), Article 3. <https://doi.org/10.6092/issn.1970-2221/18250>
- Patil, S., & Rasave, A. (2021). Artificial intelligence chat bot for counselling therapy (SSRN Scholarly Paper 3866861). <https://doi.org/10.2139/ssrn.3866861>