DSC102 AI Tutor

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I. INTRODUCTION

Students increasingly rely on Large Language Model (LLM) tools to assist with assignment questions. However, studies indicate that students often over-rely on these tools without fully grasping the underlying concepts [1]. To address this, our project introduces DSC102 AI Tutor, an application designed to support student learning by generating personalized practice quizzes and tracking learning progress over time. DSC102 AI Tutor, is tailored for the course "DSC102 - Systems for Scalable Analytics," a class frequently described on platforms like Reddit as both "the most useful" and "the most challenging" course students have taken [2], [3]. By focusing on this course, our tool aims to help students actively engage with challenging material and foster a deeper understanding through self-assessment.

II. DESIGN EXPLORATION OF DSC102 AI TUTOR

In this section, we present the design process of DSC102 AI TutorInitially, we modeled the tool after existing LLM-based solutions. User feedback revealed that this approach did not effectively help students engage with and understand the course material. Based on this feedback, we redesigned DSC102 AI Tutor, to function as a quiz-generation and learning-tracking tool. This revised design aims to help students identify knowledge gaps and focus on areas needing improvement. The updated version received positive feedback, suggesting its effectiveness in enhancing student understanding.

A. Initial Version of DSC102 AI Tutor

The initial version of DSC102 AI Tutor, turned out to be similar to existing LLM-based tools, offering an open dialogue system for students to ask questions about DSC102 course material. All course materials, including lecture notes and cheat sheets, were integrated into the system to provide accurate and relevant answers. Additionally, students could adjust a hint-level slider, ranging from 1 (minimal hint) to 5 (maximum hint), to control the depth of assistance provided.

This version also included a feature to generate practice questions based on the questions students asked, allowing them to attempt answers independently. After completing a question, students could click a dedicated button to reveal the correct answer. To further support their learning, the system recommended additional reading materials tailored to the questions students asked.

The initial version can also track students' interactions, monitoring what questions they asked and over which topics. We expected students to review their learning history and identify weaker areas over time.

B. User Feedback to Initial Version of DSC102 AI Tutor

We then asked 3 students who have taken DSC102 and 3 students who are currently taking DSC102 to experience the application for 30-minute and give us feedback on our initial version of DSC102 AI Tutor . User feedback collected highlighted several limitations in its design and functionality. One common feedback was that the application felt similar to existing tools like ChatGPT or Claude, where students could still over-rely on generated answers without fully understanding the underlying concepts (e.g. *While it answers questions accurately, I find myself just reading the answers instead of really learning the material*).

The tracking feature, intended to help students identify weak areas, can make students sometimes misinterpreted their learning needs. For example, one student noted, *I like that the app tracks what I am struggling with, but sometimes it marks topics as weak just because I was curious and asked more questions*. This highlighted the need for the tracking system to better distinguish between exploratory questions and genuine learning gaps.

Additionally, the hint-level slider was found to be inefficient. While users appreciated the ability to adjust the level of assistance, they could not confidently gauge whether their answers were correct (e.g. *The hints are helpful, but what's the correct answer?*).

C. Final Version of DSC102 AI Tutor

In the final version of DSC102 AI Tutor, we redesigned the tool to address the limitations of the initial version and to provide a more effective and targeted learning experience for DSC102. The updated DSC102 AI Tutor, was reimagined as a quiz-generation and learning-progress tracking tool. This iteration introduced new features and refinements informed by user feedback and technical exploration.

To align the tool with the course objectives, we collaborated with teaching assistants to gather additional lecture slides and past exams. The course materials were reorganized into a data folder, stored as `dsc102.txt`, and further divided into weekly files (Weeks 1-10) and concept-based files. This organization enabled students to generate quizzes tailored to their needs: they could create quizzes for specific weeks (Weeks 1-10) with a customizable number of questions (1-20) or focus on concept-based quizzes to target specific topics. To discourage over-reliance on LLM-generated answers, students were required to input their answers before accessing the correct ones.

To address the lack of insight into students' learning progress in the initial version, we implemented a concept-based error tracking system. After completing

quizzes, students' responses were evaluated using the *grade_quiz_question_2* function, which categorized each question as correct or incorrect. The results were stored in AWS, with each student assigned a unique file containing a dictionary of concepts paired with their error frequencies. A separate file maintained a detailed history of correct and incorrect responses across quizzes. This tracking system allowed students to monitor their progress over time and better organize their study plans, such as identifying which topics to review for midterms or finals.

During the redesign process, we explored improving the accuracy of correct answers generated for quizzes by incorporating a chain-of-thought reasoning approach. This involved combining *grade_quiz_questions* and *grade_quiz_questions_2* to enable self-iteration during evaluation. By running this process twice, we aimed to double-check the correctness of answers and improve reliability. However, this approach proved impractical due to its high runtime, making it unsuitable for real-time student interactions. Consequently, we reverted to a more efficient, though slightly less rigorous, method for generating and grading quiz answers.

To further support students, we integrated the SHARP API to provide external learning resources. Using the *search_concept_links* function, the tool retrieved the top five relevant links for any given concept. This feature allowed students to access curated materials and deepen their understanding of challenging topics.

D. Feedback for Final Version of DSC102 AI Tutor

To evaluate the practicality and effectiveness of the final version of DSC102 AI Tutor, we gathered feedback from the same six students who tested the initial version. The students highlighted that DSC102 AI Tutor, significantly reduced their reliance on AI-generated answers compared to tools like ChatGPT or Claude. One student commented, "Unlike other LLMs, where I tend to just accept the answer, DSC102 AI Tutor, made me think through the questions before seeing the correct answer" This shift towards active learning was attributed to features such as requiring students to input their answers before accessing the correct ones and tracking their progress over time.

Students also noted that the error tracking and quiz customization features helped them better understand their learning gaps. By providing detailed feedback on which concepts needed improvement, DSC102 AI Tutor, enabled students to organize their revision plans more effectively, particularly when preparing for midterms and finals. One student remarked, "I now know exactly which topics I need to review before exams, rather than just guessing or relying on what ChatGPT tells me."

Additionally, we sought feedback from the teaching assistants of DSC102. They praised the tool's practicality, noting that it aligned well with the course objectives and encouraged students to engage more deeply with the material. The teaching assistants also appreciated the tool's ability to guide students in identifying weak areas and focusing their efforts where needed, a feature that generic LLMs often lack.

III. DISCUSSION AND FUTURE WORK

Throughout this project, we grew not only as students but also as application developers. One of the most important lessons we learned was the need for clarity in defining how our tool would help students before moving onto the design phase. Early in the process, we realized that having a clear understanding of our users' needs is essential to developing an effective tool. By prioritizing user feedback and focusing on practical learning challenges, we were able to refine DSC102 AI Tutor, into a tool that actively engages students and supports their learning process.

We believe that by open-sourcing our code, the tool could have broader applications beyond DSC102. Both students and instructors could adapt DSC102 AI Tutor, for other courses with minimal effort. To implement the tool for a new course, the only preparation required would be organizing the course materials and dividing them into weekly or concept-based files. With this setup, DSC102 AI Tutor, could assist in learning a wide range of subjects, making it a versatile tool for education.

During the development process, we also experimented with self-evaluation techniques to improve the accuracy of generated answers. By employing a chain-of-thought reasoning approach, we aimed to double-check answers and enhance reliability. However, this approach proved to be too slow for real-time interactions, making it impractical for our current implementation. Future work could focus on optimizing runtime for self-evaluation techniques while maintaining or improving accuracy. Incorporating faster, more efficient algorithms or leveraging advancements in LLM capabilities could make this feature feasible in future iterations.

IV. CONCLUSION

DSC102 AI Tutor, addresses the challenges of over-reliance on AI-generated answers and lack of insight into learning progress by providing targeted quizzes, progress tracking, and actionable feedback. Through user feedback and technical exploration, we refined the tool into a practical and effective learning aid for DSC102. With its customizable features and potential for broader application across other courses, DSC102 AI Tutor, serves as a step forward in educational technology. Future work will focus on optimizing runtime and expanding functionality to further improve its impact.

REFERENCES

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