AI-powered tutoring: An interdisciplinary approach to enhancing college student learning outcomes

JIE ZHANG and LAURA FONSECA-LLORCA and LIAM DAVIES and SANDEEP MITRA and NING YU

KEYWORDS

Artificial intelligence (AI), AI-powered tutoring, interdisciplinary collaboration, student learning outcomes, higher education

doi: 10.22488/okstate.25.100628

Artificial intelligence (AI)-driven applications have emerged as promising educational technology tools to enhance accessibility in education, offering personalized feedback and adaptive learning pathways (Krstić et al., 2022). With the rapid development and widespread accessibility of AI, it is crucial for teacher candidates to be exposed to the opportunities of exploring AI with appropriate guidance, so they will be better prepared for AI-integrated education in Kindergarten through 12th grade settings.

At SUNY Brockport—a part of the State University of New York system where this research is being conducted—despite the rapid growth and easy access to AI tools, there is no policy regulating their use. Faculty have the autonomy to decide the extent to which their students are allowed to use AI, ranging from encouraging its use with reflection and appropriate citations, to imposing restrictions, and prohibiting its use entirely.

Feeling a sense of urgency, Dr. Jie Zhang, a professor of special education, sought to integrate AI into her teaching to meet her teacher candidates' needs. In addition to the lack of official policy from the university, another challenge was to maintain the confidentiality of students' work without using a free OpenAI platform. To address these concerns while providing her teacher candidates with experience in using AI, Zhang turned to Dr. Ning Yu and Dr. Sandeep Mitra from the Department of Computing Sciences for assistance.

Concurrently, Yu and Mitra were exploring new approaches to computer education in the AI era, recognizing how AI is driving a potentially revolutionary change in computing education (Denny et al., 2024). Following a "learning by doing" model, Yu collaborated with Mitra, Zhang, and other colleagues to launch SUNY Brockport's inaugural Association of Computer Machinery Special Interest Group in Artificial Intelligence (ACM SIGAI) student chapter, aiming to sharpen students' computer science skills, particularly in AI, and equip them with cutting-edge technologies in this rapidly evolving field. Before the ACM student chapter was officially formed, Laura Fonseca-Llorca, an undergraduate student majoring in Computer Science, had been conducting independent research on developing an AI-based prototype using LLMs to enhance teaching and learning. Once the student chapter was established, the independent study transitioned into an ACM project, enabling other chapter members to establish a student development team and participate in creating educational software with real-world impact.

In this outtake, we share our journey of overcoming challenges through interdisciplinary collaboration across Computer Science and Education. When conducting the project, we integrated AI into teaching, addressed issues of assessment accessibility and inclusivity, and gauged students' understanding through AI-powered educational assessment. More specifically, we utilized immediate, targeted AI feedback and automated grading to make the tutoring experience more supportive and equitable, and fostered a community of practice through collaboration.

The Challenges, Impact, and Resolutions

Due to the interdisciplinary collaborative nature of this project, the first challenge we encountered was a question: Where should we start? At our first team meeting, Mitra, whose expertise lies in capturing customer requirements and designing software solutions to create systems, facilitated a crucial discussion to map the overall workflow of the proposed product. Figure 1 illustrates our initial "back of the envelope" brainstorming stage, which identified the central role of AI-generated feedback on student answers. This preliminary conceptual workflow evolved into a formalized implementation framework by the student development team, which was responsible for the product architecture, design, and coding, as shown in Figure 2. The progression between Figures 1 and 2 demonstrates the transition from theoretical concept to practical software architecture, highlighting how our interdisciplinary team bridged conceptual ideas and technical implementation requirements while addressing user interface considerations that were not apparent in our initial conceptualization.

Once the project structure was outlined, Zhang selected the course Introduction to Special Education—specifically the Autism module—for the pilot. She collaborated with the team to outline how students would engage in a two-attempt assessment process. In the first attempt, students answered eight short-answer questions on autism. After submission, AI provided immediate and individualized feedback tailored to the student's answers and graded students' responses based on a predefined rubric. For the second attempt, students revised their answers for improvement, self-evaluated their performance, and responded to two reflective questions about their experience using AI in the process. Zhang supplied the student development team with all relevant teaching materials, questions, the rubric, and answer key for this autism module.

Figure 1

Initial Workflow Chart (Mitra & Zhang, 2024)

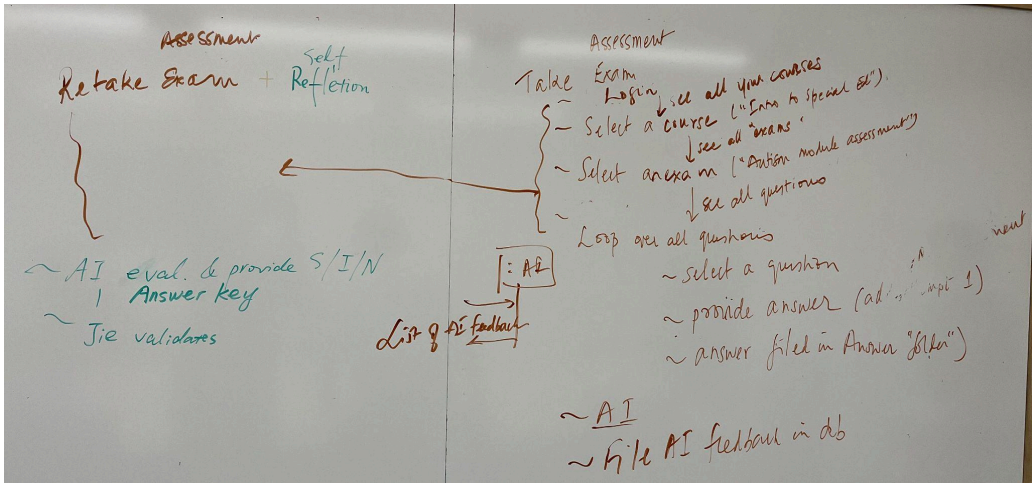
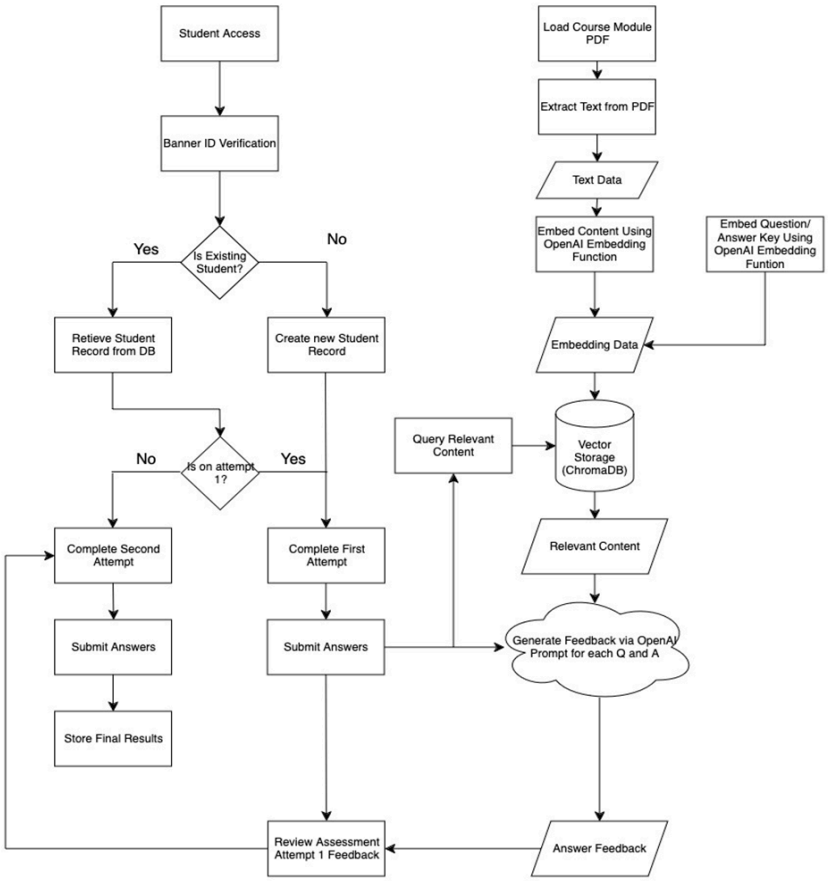
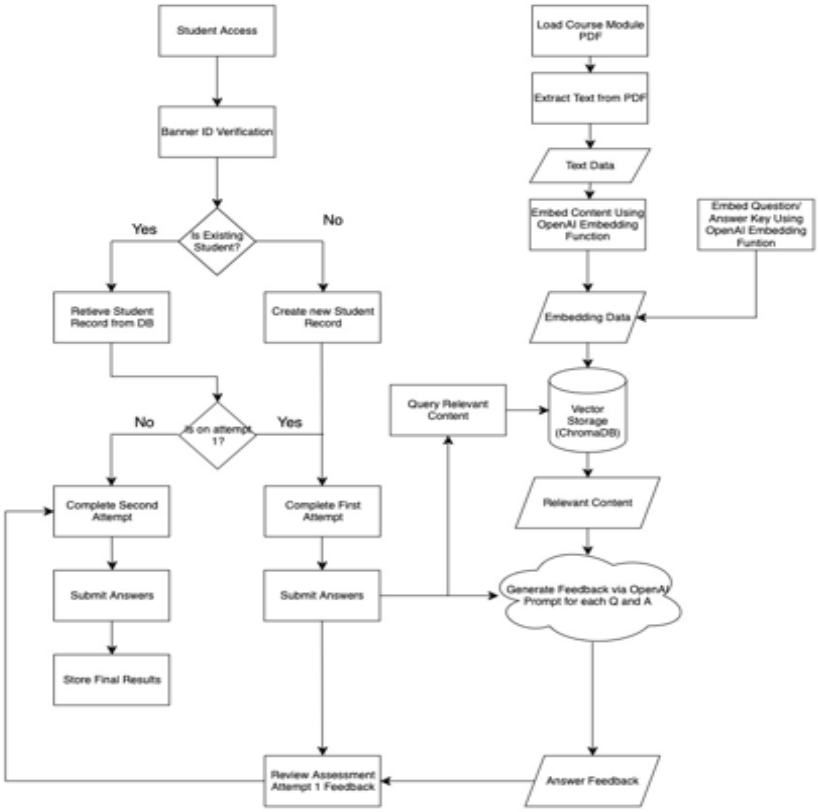


Figure 2

Finalized Workflow Chart (Fonseca-Llorca & Davies, 2024)





The second challenge was to build an AI-powered tutoring application, ensuring accessibility, privacy, and productivity while enhancing learning. The student development team designed a tutoring application with several key features. It is device-independent, working across any device or operating system, and even functional offline, ensuring availability for all users regardless of location. It incorporates a speech-to-text function that enables students to answer questions verbally during assessments, offering flexibility and accessibility to students beyond traditional methods. It facilitates anonymous submissions to protect privacy, requiring only the last four digits of student school IDs for instructor verification purposes. The application automates the assessment process, significantly reducing completion time, ensuring accuracy and consistency of grading by minimizing human error, and enhancing efficiency for both students and instructors based on given instructional materials, rubrics, and answer keys.

The AI-powered feedback system is another valuable feature, powered by prompt engineering and designed to deliver customized, constructive feedback by comparing student responses to instructional materials, answer keys, and rubrics. This two-step approach first provides initial positive feedback on what the student did well, then identifies areas for improvement while directing them to relevant sections of the materials for further study. It is especially effective in practice exams, study tutoring, and early assessments, allowing students to self-assess and focus on targeted improvements to build confidence and encourage deeper learning.

Prompt engineering is at the core of this application's AI-powered feedback system, which adapts to individual student needs and educational goals without requiring extensive model training. With carefully crafted prompts, AI provides clear, relevant, and constructive feedback for each response. This exclusive reliance on prompt engineering makes the application flexible and efficient while delivering accessible and supportive experiences for students.

Implications and Future Directions

This AI-powered two-step feedback system, empowered by prompt engineering, enhances accessibility and inclusivity in educational assessments through targeted, timely, automated feedback. Therefore, the application engages students in personalized learning, builds their confidence, and deepens their understanding. Rather than replacing educators, AI complements educator support and assists students in monitoring their learning through automated feedback, self-assessment, and self-improvement. By identifying knowledge gaps, the application empowers learners to take control of their education. As Hattie and Timperley (2007) stated, positive feedback increases the likelihood that students will continue attempting activities with higher interest levels.

Future updates of this application will include secure logins for both teacher and student accounts, enhancing management and oversight while ensuring the privacy and security of user data. The team will also expand its implementation to additional disciplines, such as biology and mechanical engineering, to support diverse educational needs across broader content areas.

In conclusion, this AI-powered tutoring application represents a significant advancement toward more accessible and inclusive educational assessments. By leveraging AI for reflection, grading, and inclusive tutoring, this application enhances

learning opportunities for students with varying needs. This pilot project not only demonstrates how AI can facilitate learning but also emphasizes its role as a supportive tool that enriches educational experiences without replacing human educators.

References

Denny, P., Prather, J., Becker, B. A., Finnie-Ansley, J., Hellas, A., Leinonen, J., Luxton-Reilly, A., Reeves, B. N., Santos, E. A., & Sarsa, S. (2024). Computing education in the era of generative AI. *Communications of the ACM, 67*(2), 56–67. https://doi.org/10.1145/3624720

Fonseca-Llorca, L., & Davies, L. (2024, November 15). *EduAlly pilot results: Insights, improvements, and future vision*. [Presentation] AI-OER Faculty Learning Community Meeting, Brockport, NY.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81–112. https://doi.org/10.3102/003465430298487

Krstić, L., Aleksić, V., & Krstić, M. (2022). Artificial intelligence in education: A review. *The 9th International Scientific Conference Technics and Informatics in Education – TIE 2022,* 223–228. doi: 10.46793/TIE22.223K

Mitra, S., & Zhang, J. (2024, October 8). *Initial workflow chart for the EduAlly pilot project*. [Presentation] AI-OER Faculty Learning Community Meeting, Brockport, NY.