

ASCILITE 2025

Future-Focused:

Educating in an Era of Continuous Change

Course-aligned generative AI-based intelligent tutoring: Adaptive, scalable, and aligned with learning needs

Abdullahi Chowdhury, Siamak Mirzaei, Mohammad Afikuzzaman

UniSA Online (STEM), University of South Australia

Intelligent tutoring systems (ITS) utilise artificial intelligence to deliver personalised educational content, guidance, and feedback. Recent advances in Generative AI (GenAI) have shown considerable promise in the development of ITSs, offering the potential to provide highly tailored educational experiences. However, current GenAI-based systems frequently suffer from critical limitations such as content hallucination, generation of overly complex responses, and misalignment with defined course objectives, undermining pedagogical effectiveness and risking academic integrity.

Existing GenAI-powered educational tools often rely on vast, unfiltered internet-sourced training data, lacking the ability to restrict outputs exclusively to course-specific materials. This typically results in feedback that is either overly generic, misaligned with curriculum sequencing, or pedagogically inappropriate. Traditional ITSs, relying on rigid, rule-based structures, similarly face difficulties in capturing the nuanced, context-rich language typical in higher education environments. Research suggests potential solutions using context-free grammar (CFG) and predictive parsing techniques. Nevertheless, these methods have traditionally been limited to experimental laboratory environments, and their efficacy in comprehensive educational contexts remains underexplored.

This research addresses these gaps by proposing a novel intelligent tutoring platform that integrates CFG and Earley's parsing algorithm with a GenAI model specifically trained on curated, course-aligned content. Unlike traditional systems, our approach uniquely considers the student's specific position within the course learning trajectory and their current understanding level, ensuring output is both cognitively appropriate and pedagogically relevant. For instance, if a student demonstrates difficulties in Week 6 activities, the system intelligently identifies underlying conceptual gaps originating from earlier weeks (e.g., Week 2) and delivers targeted, remedial content precisely aligned with their immediate learning needs.

The integration of CFG with Earley's parsing within a generative AI framework ensures pedagogical consistency, computational efficiency, and ease of integration with existing university infrastructure. By restricting content generation strictly to validated course materials, the system significantly reduces the risks associated with hallucinations and ensures alignment with educational objectives.

A pilot study across two STEM courses within UniSA Online will evaluate this system's effectiveness in providing accurate, relevant, and cognitively aligned content. Key research questions include:

- How effectively do GenAI-generated assessments and feedback align with course learning outcomes compared to instructor-authored materials?
- Does the integration of CFG and Earley's parsing significantly mitigate hallucinations and curricular drift?
- To what extent can the system reduce academic staff workload related to assessment creation and personalised student feedback?

Anticipated outcomes include improved alignment between assessment content and learning outcomes, enhanced personalised learning experiences, reduced academic workload, and valuable data for continuous course improvement. Deliverables encompass a fully operational tutoring platform, reusable grammar libraries, implementation guides, training resources, and scholarly publications.

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This project contributes significantly to Technology Enhanced Learning (TEL) by advancing theoretical and practical understanding of effective, course-aligned GenAI application. This project pioneers a new class of intelligent tutoring systems, course-aligned, hallucination-resistant, and responsive to individual learner trajectories. Its scalability and adaptability across diverse tertiary contexts underline its value for broad educational innovation, aligning strongly with UniSA's strategic goals in fostering pedagogical excellence, integrity, and technological leadership in online education.

Keywords: intelligent tutoring systems, generative AI, context-free grammar, Earley's parsing, personalised learning

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