Evaluating the Educational Impact of AI-Powered Virtual Laboratories in Mechanical Design Education

Project Description

Artificial intelligence is increasingly being integrated into educational technologies, creating new opportunities to support student learning through personalized guidance, feedback, and adaptive assistance. This project aims to evaluate the educational effectiveness of a suite of AI-powered virtual laboratories developed for a Mechanical Design course, including modules on gear design, spring design, and fatigue analysis.

These virtual laboratories allow students to perform design calculations, explore engineering concepts, visualize system behavior, and receive AI-generated feedback throughout the learning process. While AI has the potential to improve learning outcomes, an important question remains: What type and level of AI assistance best supports learning without reducing students' opportunities for critical thinking and problem solving?

The project will investigate how different forms of AI support—including hints, guided questioning, feedback, explanations, design recommendations, and adaptive scaffolding—affect student learning, engagement, confidence, and knowledge retention. The team will evaluate whether certain AI interventions promote deeper understanding and productive struggle, while others may encourage overreliance on AI-generated solutions.

Using a combination of learning analytics, surveys, assessments, user interaction data, and student reflections, the project will identify which AI-assisted learning strategies are most effective in helping students develop engineering design knowledge and problem-solving skills.

In addition to the educational evaluation, students may contribute to improving the virtual laboratory platform itself. Depending on the individual's interests and skills, the project may involve refining AI prompting strategies, developing new feedback mechanisms, enhancing user interfaces, improving data collection pipelines, and implementing additional educational features.

Note: Experience with web development is considered an asset. Familiarity with frontend technologies (e.g., HTML, CSS, JavaScript, React) and/or backend development (e.g., Python, Node.js, databases, APIs) may enable students to contribute to the development of AI features, learning analytics systems, user interfaces, and data infrastructure supporting the virtual laboratory platform.

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