Poster: Adaptive AI tutors in extended reality environments: enhancing cognitive engagement through neurofeedback

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Abstract

Introduction
This doctoral research explores how to design adaptive immersive learning environments by leveraging Artificial Intelligence (AI), Extended
Reality (XR), and neurofeedback (NF). The goal is to improve immersive education by creating a system that can respond in real time to students' cognitive states - like focus attention or confusion - through neurofeedback. By doing this, the study aims to boost student engagement and support better learning outcomes.

Research Questions
Primary
• How can we design an effective immersive system that leverages dynamic cognitive recognition to deliver intelligent, personalised learning and enhance student engagement?
Secondary
• How does the cognitive load experienced by students in AI-driven XR learning environments compare to that in traditional XR settings?
• How can real-time neurofeedback be utilized to dynamically adapt AI tutor responses to individual student needs in XR environments?

Design and Methodology
This research adopts a multidisciplinary approach by integrating and comparing the effectiveness of different learning settings within immersive environments. Experimental studies will be conducted in higher education settings to assess the system's impact on learner engagement, retention, and cognitive load. Data collection will follow a mixed-methods approach, where EEG data will be recorded and analysed. This data will also be used to develop a neurofeedback algorithm that supports the creation of an adaptive, personalised learning
environment. In addition, students will take part in post-session interviews to collect qualitative data regarding their satisfaction with the system.

Significance
The study bridges a critical gap in empirical research by exploring the synergy between AI, XR, and NF in real-time adaptive learning. It offers valuable insights into designing immersive systems that respond to learners' mental states.

Practical Implications
The research provides a scalable framework for personalised education, including practical guidelines for implementing neuro-adaptive learning in mixed reality classroom settings. The approach holds particular promise for supporting learners with ADHD and enhancing STEM education.

Keywords

AI, Extended reality, Neurofeedback