Harnessing AI for enhanced learning: Insights from the robotics academy

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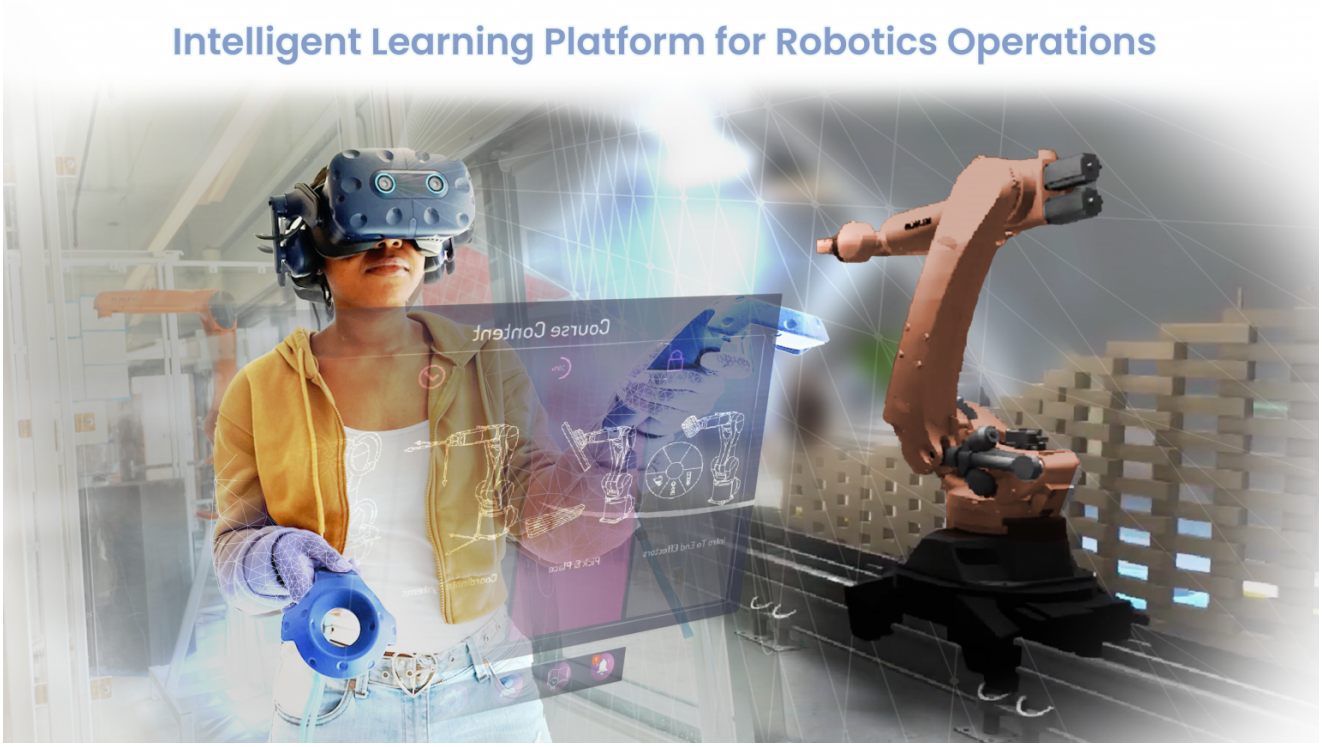

How technology is tailoring personalised learning experiences for the AEC sector

Personalised learning, tailoring learning content and sequence for differences in ability, experience and sociocultural backgrounds holds the promise to transform education. This transformation is propelled by three significant advancements in emerging technologies, each vital in realising personalised learning.

The first of these advancements is in learning analytics, defined as the measurement, collection, analysis and reporting of learner data (Siemens, 2013). Enhanced by AI and data mining techniques, learning analytics significantly deepens our understanding of learning processes by systematically monitoring learners' performance and actions. This involves analysing extensive datasets from learner interactions to uncover patterns, challenges and cognitive load, providing a comprehensive view of the learning experience.

The second major technological stride is the recent progress in Adaptive Intelligent Learning Systems (AILS). These systems form the foundation for personalised learning by tailoring the educational process to each learner's unique needs. AILS utilises learning analytics to adapt

educational content to each student's specific learning level and background. By continually monitoring student progress, AILS can dynamically adjust content complexity and difficulty in real-time and provide customised feedback, making the learning experience more personalised and responsive.

Lastly, advancements in immersive and interactive technologies, such as computer graphics, simulation algorithms and spatial computing hardware, have significantly enhanced learning environments. This is particularly evident in the use of virtual reality (VR) and augmented reality (AR), as noted by Davis et al, 2018 and many others. These technologies provide rich, interactive learning experiences while facilitating the collection of diverse data through AR and VR headsets equipped with various sensors. This data collection is integral to performing in-depth analytics, further enhancing the personalisation and effectiveness of the learning experience.

The subsequent sections of this article provide an overview of the Robotics Academy, an innovative project that leverages these technological advancements into a comprehensive training platform. This project unfolds in three distinct phases, each developed with the support of the National Science Foundation (NSF). Representing a synergy of efforts, the project brings together an interdisciplinary team of experts from architecture, computer science, engineering and construction across four different institutions.

Robotics Academy

The Robotics Academy was conceived in response to the rapid changes in the building industry driven by Industry 4.0, where robotics automation and digital fabrication are poised to revolutionise design and construction practices. This project is strategically designed to provide in-depth training in robotic automation for both students and professionals within the architecture, engineering and construction (AEC) sectors. Its central aim is to provide them with critical skills and comprehensive support, empowering them to manoeuvre through and adapt to the industry's growing realm of robotic automation.

The project provides an online learning platform offering content through immersive multimedia lessons and interactive tasks and activities delivered in VR. The project's initial phase, or the planning stage, included interviews and focus groups with automation engineers, software developers, AEC specialists, faculty and students to identify training needs and challenges of the industry. Building on the insights from this process, the project plan led to the development of two components, one targeting industrial robotics arms and the other focusing on small-scale robotics.

Adaptive Intelligent Learning System

At the core of both components of the project is the creation of AILS, which plays a crucial role in personalising educational content to meet the unique needs of each learner. AILS comprises two primary models: the learner model and the domain model. The learner model is designed to capture an extensive profile of each student. It includes the learner's demographics, academic background and previous experience.

More importantly, it collects performance data during the student interaction with the system. This includes tracking diagnostic test scores, engagement and levels during activities, and telemetry data such as decision-making time, task completion time, number of attempts, error rates and types.

Concurrently, the domain model forms another essential component of AILS. It contains educational content, the backbone of the learning materials covering various topics and subject areas. This model not only integrates a particular pedagogical approach to guide effective teaching methodologies and strategies but also incorporates instructional prompts that are geared towards enhancing learner engagement and facilitating a more productive study experience.

User Experience (UX) and User Interface (UI) Design are two other pivotal components in delivering IALS effectively. UX design centres on optimising the overall user interaction with the platform, ensuring it is intuitive and user-friendly. Meanwhile, UI design concentrates on the platform's visual and functional elements, like layout, buttons and colour schemes, striving to create an interface that is visually appealing and easy to navigate.

Virtual reality and data collection

The project utilises a VR environment created using the Unity game engine to facilitate immersive learning experiences. Within this environment, students engage in interactive simulations with robots to perform various activities. This immersive VR setup allows in-depth monitoring of students' interactions, capturing their experiences. Key performance indicators are automatically recorded with the VR headsets.

Additionally, the system collects verbal interactions to gauge learners' comprehension and confidence level. This comprehensive data collection is processed by natural language processing and machine learning algorithms and integrated with the AILS to personalise the learning experience, dynamically adjusting the content and providing just-in-time feedback.

Closing remarks

This article underscores the critical impact of emerging technologies in redefining educational paradigms, with the Robotics Academy serving as an example of their application in fostering personalised learning. Integrating learning analytics, AILS and immersive VR technologies within the project provides a robust framework for specialised training.

The interdisciplinary research conducted for the Robotics Academy exemplifies how technology can potentially transform learning by tailoring educational experiences to meet the specific needs of learners in the AEC sectors. This transformation ensures alignment with the latest industry advancements and evolving workforce demands.

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Project Team

Shahin Vassigh, Biayna Bogosian, Mark Finlayson, Agoritsa Polyzou, Gregory Murad Reis, Debra Davis, Florida International University; Seth Corrigan, University of California, Irvine; Eric Peterson, University of Hawaii; Shu-Ching Chen, University of Missouri, Kansas City

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