Abstract

Augmented Reality (AR) technology has gained significant attention in various educational contexts due to its potential to enhance learning experiences. This thesis explores the development and evaluation of an AR application for an engineering drawing course, focusing on its effectiveness and usability across three types: marker-based, markerless, and web-based AR. The research involved three extensive experiments assessing learning performance, cognitive load, usability, 3-D visualization, AR acceptance, motivation, visual attention, and cognitive workload. The first experiment, involving 392 first-year engineering students, assessed a marker-based AR application alongside a traditional teaching method. Results indicated that the AR application enhanced learning performance, offering an improved understanding of complex concepts like orthographic projection through interactive 3-D visualizations. It also reduced cognitive load and scored high on usability. In the second experiment, a total of 140 undergraduate students participated and we compared the three different types of AR applications. This study, involving both experimental and control groups, showed that all AR groups improved learning performance, motivation, and spatial ability, with the markerless and web-based versions particularly reducing cognitive workload. The markerless AR showed a slight advantage in cognitive workload reduction, while the web-based version stood out for its accessibility and convenience. The final experiment focused on the markerless AR version, using eye tracking and Open Face analysis for measuring visual attention and user experience assessment. In total, 45 participants were involved in this experiment, consisting of one control group and two experimental groups. The experimental groups utilized AR and physical models for learning purposes. Results revealed that the markerless AR effectively captured visual attention, leading to increased engagement and improved cognitive processing. Eye tracking offered insights into visual attention in AR environments, and usability evaluations confirmed the user-friendly nature of the markerless AR application.

Keywords: Augmented reality, engineering drawing, 3-D visualization, cognitive load, learning motivation, usability, learning performance, AR acceptance, visual attention, facial behaviour recognition.