SCHOLARSHIP OF TECHNOLOGY ENHANCED LEARNING

Mixed Reality (XR) research and practice: Exploring a new paradigm in education

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Abstract:

Up until recently, learning affordances (possibilities) offered by immersive digital technology in education, such as augmented reality (AR) and virtual reality (VR), were addressed and considered in isolation in educational practice. In the past five to ten years this has shifted towards a focus on integrating digital affordances around particular learning contexts and/or settings, creating a mixed reality (MR) 'continuum' of digital experiences based on the combination of different technologies, tools, platforms and affordances. This idea of a 'digital continuum' was first proposed during the mid 1990s by Milgram and Kishino (1994), conceptualised as an immersive continuum going from the real environment (RE) end, where no digital immersion exists in the real world, all the way to the fully digitally immersive VR end, where digital immersion is at its full (see Figure 1).
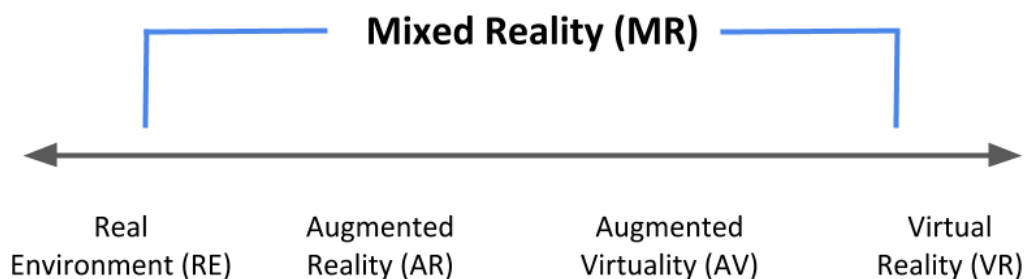
Figure 1. The mixed reality digital continuum (*adapted from* Milgram & Kishino, 1994).

Recent literature expands the original digital continuum view – rooted in Milgram and Kishino (1994), to now consider MR environments extending to a multi-variety of sensorial dimensions, technological tools and networked intelligent platforms, and embodied user engagement modes, creating interconnected learning ecosystems and modes of perception (see for example Mann et al., 2018; and Speicher, Hall & Nebeling, 2019). This new approach to MR is referred to as XR, where the X generally stands for 'extended reality' (referring to all the points along the MR continuum and beyond), or for 'anything reality' (accounting for the range of existing immersive technologies and denoting the imminently yet-to-come new digital affordances). XR as a multi-dimensional immersive learning environment can be approached and understood as a dynamic and culturally-responsive 'medium', offering targeted, flexible and adaptable user experiences coming from user-centric learning design strategies and pedagogy (Aguayo, Eames & Cochrane, 2020).

Today, XR as an emergent learning approach in education invites us to re-conceptualise technology-enhanced learning from a completely different epistemological stand. We have moved from focusing on the individual and isolated use of immersive digital technology like AR and VR as 'learning tools' that can enhance and augment learning experiences and outcomes in education; to now going beyond hardware and software and consider perception, cognition, aesthetics, emotions, haptics, embodiment, contexts (space), situations (time), and culture, among others, as critical components of a purposefully designed XR learning ecosystem (Aguayo et al., 2020; Liu et al., 2017; Maas & Hughes, 2020). Imagine the educational possibilities when artificial intelligence (AI) learning algorithms connected to internet of things (IoT) devices come into play with XR in education (Cowling & Birt, 2020; Davies, 2021).

The challenge remains in knowing how to ground such epistemological and technological innovation into authentic, contextual, and tangible practice, while facilitating the balancing with non-technology mediated lived experiences in the real world (i.e. real reality (RR), Aguayo, 2017). Here, a set of XR research and practice case

studies from Auckland University of Technology's AppLab are presented to showcase and discuss how XR as a new paradigm is leading the exploration of digital innovation in education.

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