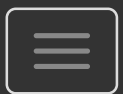


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## Augmented Reality and Mobile Learning: The State of the Art

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## Abstract

In this paper, the authors examine the state of the art in augmented reality (AR) for mobile learning. Previous work in the field of mobile learning has included AR as a component of a wider toolkit but little has been done to discuss the phenomenon in detail or to examine in a balanced fashion its potential for learning, identifying both positive and negative aspects. The authors seek to provide a working definition of AR and to examine how it can be embedded within situated learning in outdoor settings. The authors classify it according to key aspects (device/technology, mode of interaction/learning design, type of media, personal or shared experiences, whether the experience is portable or static, and the learning activities/outcomes). The authors discuss the technical and pedagogical challenges presented by AR, before looking at ways in which it can be used for learning. Finally, the paper looks ahead to AR technologies that may be employed in the future.

## Article Preview

## Defining Technology Enhanced Realities: Virtual, Mixed And Augmented

Milgram et al. (1994) provide a helpful representation of how reality and virtuality are connected (see Figure 1). This shows a continuum encompassing all real and virtual objects and environments. Mixed reality is an area in the middle, where the two extremes meet, and is considered a blend of the virtual and the real.

Figure 1. Representation of the reality-virtuality (RV) continuum, re-drawn from Milgram et al., 1994



Azuma (1997) defined AR as “3-D virtual objects [â€] integrated into a 3-D real environment in real time”, reflecting early research into the use of AR as a primarily graphical display. We consider this definition too narrow and prefer a working definition of AR that includes the fusion of any digital information with physical world settings, i.e. being able to augment one’s immediate surroundings with electronic data or information, in a variety of formats including visual/graphic media, text, audio, video and haptic overlays. Indeed, in a later paper, Azuma et al. (2001) updated his definition, reducing the emphasis on graphical objects and identifying the three essential properties of AR as: the combination of virtual and real objects in a real environment; a system that aligns/registers virtual and real objects with each other; and that runs interactively in real time. Their paper also defines “mediated reality” or “diminished reality”, where some real objects are electronically stripped out, so users are better able to focus on other aspects of their environment.

A critical aspect of AR is the *dialogue* between the media and the context in which it is used, i.e. how the media responds to and changes that context. It is not enough to state that AR consists of availability or presence of digital media within a particular location, as this could encompass passers-by playing music on their mp3 players as they travel through that environment. Rather, we need to take into account the *explicit intention* of the digital media deployment, to supplement or augment our surroundings through additional information being made available (e.g. visually, auditory or through haptic interfaces) that has contextual relevance to that specific place.

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