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What are the educational affordances of wearable technologies?

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ABSTRACT

By providing users with hands-free access to contextually relevant knowledge, wearable technologies are poised to inspire a new generation of mobile learning design. However, in order for educators to harness the pedagogical opportunities of wearable technologies it is crucial for them to develop an understanding of their potentials, or 'affordances'. This paper analysed the perceptions of 66 educators from around the world who self-rated as having a 'good' or 'very good' understanding of wearable technologies to determine the key educational affordances and issues at stake. Qualitative thematic analysis of participant perceptions, as well as relevant literature, revealed fourteen affordances of wearable technologies and thirteen issues relating to their use. These clustered together into three emergent themes; 'pedagogical uses', 'educational quality' and 'logistical'. Utilising the insights of knowledgeable practitioners resulted in nine affordances and issues not identified in the literature, and within the literature there were three issues not identified by the knowledgeable practitioners. The implications of findings for the future of wearable technology learning design are also discussed.

1. Introduction

Wearable technologies constitute a shift from digital simulation (replication and separation) to digital augmentation (connectivity and responsiveness) (Viseu, 2003). Recently, there has been an explosion in the range of wearable technologies available to educators. As at 10th of April 2015 the Vandrico Wearable Technologies database (http://vandrico.com/wearables) includes 296 devices across a range of sectors including fitness, medical, entertainment, industrial, gaming and lifestyle sectors. For instance, head mounted display products such as Google Glass and Oculus Rift can provide users with audio-visual information to supplement their view of the world. Bracelet products such as Fitbit, Garmin, and Striiv include componentry for measuring motion and vital signs that has given rise to the 'quantified self' phenomenon (Swan, 2013). All of these products provide wireless connectivity, on-board analytics, and interfaces for hands-free feedback that avail a wide range of opportunities to educators.

There is considerable literature investigating the development and use of wearable technologies across a range of fields other than education. Wearable devices have been used for medical diagnosis, therapy of movement disorders, and administration of drugs (Son et al., 2014), for care and tracking of the elderly with Alzheimer's disease (Mahoney & Mahoney, 2010), and in conjunction with augmented reality to enable face recognition and subsequent overlay of personal information

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(Kim, 2003). However, there is a scarcity of research into the use of wearable technologies in education (exceptions include Coffman & Klinger, 2015; Wu, Dameff, & Tully, 2014; Yamauchi & Nakasugi, 2003; as discussed later in this paper).

While it is difficult to establish the exact prevalence of wearable technologies usage within education, the limited literature in this area would appear to indicate that the possibilities of wearable technology are not being fully harnessed for teaching and learning. One reason that educators may not be capitalising on the possibilities extended by wearable technologies is because they do not fully appreciate their action potentials, or 'affordances' (Bower, 2008). Without an understanding of the affordances of technologies, educators struggle to make appropriate or innovative use of them, which in turn may compromise the effectiveness of their teaching and student learning (John & Sutherland, 2005; Mishra & Koehler, 2006; Yoon, Ho, & Hedberg, 2005).

This paper reports upon an online survey that selected 66 of the most knowledgeable educators from around the world from a sample of 332 in order to examine what they perceived to be the key affordances and issues relating to wearable technologies. These results were then compared and contrasted with affordances and issues identified within the literature. The outcomes provide educators with a comprehensive conceptualisation of ways that wearable technologies may be utilised, and the key issues that need to be considered in their learning designs. It also addresses previous methodological issues surrounding classification of technology affordances by using thematic analysis of participant responses in conjunction with the research literature to derive a robust affordance framework.

2. Literature review

2.1. Research on the use of wearable technologies

In 2001, Barfield and Caudell defined a wearable computer as a:

> fully functional, self-powered, self-contained computer that is worn on the body … [and] provides access to information, and interaction with information, anywhere and at anytime (Barfield & Caudell, 2001, p. 6).

An important aspect of this definition is that the device provides access to, and interaction with, information (as opposed to a medical device such as a heart pacemaker or a pure information delivery device such as a traditional wrist watch).

Wearable technologies can incorporate a wide variety of sensors for measuring mechanical information (position, displacement, acceleration, force), acoustic information (volume, pitch, frequency), biological information (heart rate, temperature, neural activity, respiration rate), optical information (refraction, light wave frequency, brightness, luminance) and environmental information (temperature, humidity) (Barfield & Caudell, 2001). Wearable devices are 'aware' in so far that they can recognise, adapt and react to their owner, their location and the activity being performed (Viseu, 2003).

One change, perhaps cultural, since the Barfield and Caudell definition is the shift away from the monolithic concept of the 'computer' to the more agile idea of 'technologies'. Wearable technologies may be quite lightweight and specific in their purpose, yet still highly intelligent in how they fulfil their intended function. More than just technical solutions, wearable technologies constitute a shift from computers as detached tools to technologies as embodied companions that become an extension of self (Viseu, 2003).

Another paradigmatic evolution that has taken place is the shift from individuals using wearable technologies in isolation to more socially oriented uses of data. For example, wearable technologies may enable users to exchange fitness information, play games in real-time, or see an event from someone else's viewpoint (Wu et al., 2014).

Taking into account these various elements and for the purposes of this study we will define wearable technologies as:

> *Wearable digital devices that incorporate wireless connectivity for the purposes of seamlessly accessing, interacting with and exchanging contextually relevant information.*

There are only a few empirical examples regarding the use of wearable technologies in education within the literature. In an early experiment, head mounted displays were used in history education to overlay incidents from the past and live scenes from the present so that students could acquire a more visceral sense of history in the actual places that it occurred (Yamauchi & Nakasugi, 2003). Participant responses indicated that they felt a deeper connection with historical events and greater empathy with the people involved (Yamauchi & Nakasugi, 2003).

More recently, wearable technologies (such as Google Glass) have been used during medical training role-play activities to provide a first person viewpoint and recordings (Wu et al., 2014). Recordings were then used to observe the amount of time participants spent focusing on different information sources, level of attention to the patient, and other metrics that informed reflective learning and group debriefing. The first-person viewpoint into the role-play and the novel observations that led to discussion of items that were not typical in role-play tasks that had occurred without the wearable device. The hands-free nature of the device meant that it did not interfere in the role-play in any way. This led the research team to conclude that wearable devices could offer unique advantages in role-play based learning contexts with few negative consequences (Wu et al., 2014).

In another recent trial by Coffman and Klinger (2015) teachers and students were provided with access to Google Glass to use during educational psychology and organizational behaviour classes. They found that the technology was able to be seamlessly integrated into the lesson to take pictures of student work, video record class activities, access the Internet and poll students for responses to questions (Coffman & Klinger, 2015).