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# Mobile learning in review: Opportunities and challenges for learners, teachers, and institutions

Rachel Cobcroft, Stephen Towers, Judith Smith & Axel Bruns

Creative Industries Faculty

Queensland University of Technology, AUSTRALIA

*r.cobcroft@qut.edu.au, s.towers@qut.edu.au, je.smith@qut.edu.au, a.brunns@qut.edu.au*

## Abstract

*Opportunities and challenges are emerging for learners, teachers and institutions from the increasing availability of low-cost mobile and wireless devices and associated infrastructure. In order to ascertain the current state of knowledge and research, an extensive review and synthesis of the literature in mobile learning has been undertaken to identify and harness potential factors and gaps in implementation.*

*This paper presents the findings of this review. It seeks to facilitate the inquiry into ‘What is possible in m-learning?’ and ‘Why is it necessary to pursue these possibilities?’ A central theme is identified as the need to develop overarching principles and realistic visions for m-learning approaches, moving beyond specific implementations and branded technologies to examine global trends. This paper advocates the development of a best-practice framework to guide future action and thinking.*

## Keywords

*best practice; collaboration; creativity; literacy; mobile learning; social constructivism; student engagement*

## Introduction

Rapid developments in information and communications technologies (ICT) and evolving learner behaviours require learning institutions to continuously reevaluate their approaches to pedagogy, both in the physical and virtual ‘classroom’ spaces. The increasing availability of low-cost mobile and wireless devices and associated infrastructure heralds both opportunities and challenges for educational institutions and their teachers and learners. This paper considers these trends to ask: ‘What is possible in m-learning?’ and ‘Which imperatives do higher education institutions face in pursuing these possibilities?’.

The rationale to undertake a review into mobile devices was to understand and embrace the changes in learners, teachers and institutions in concert with associated ICT advances, whilst acknowledging the risks. Research into, and application of, mobile learning potentially brings the rewards of placing institutions at the forefront of pedagogical practice and addresses student requirements for flexibility and ubiquity, that is, ‘anywhere, anytime, and any device’ learner engagement. Furthermore, the review offers insights into whether mobile learning was ‘... highly situated, personal, collaborative, and long-term; in other words, truly learner-centred learning’ as envisaged by Naismith, Lonsdale, Vavoula and Sharples (2004, p. 36). The paper outlines themes and trends emerging in the literature and highlights the current status of practice and theorising beyond simple descriptive case studies.

## **Review of existing literature**

An extensive review and synthesis of the literature in mobile learning was undertaken to ascertain the current state of knowledge and research including identifying potential factors and gaps in implementation (Cobcroft, 2006). Our goal was to move beyond specific implementations and branded technologies to examine global trends, in order to present a 'what to' approach to guide future action and thinking for learners, teachers, and institutions. Over 400 recent publications were reviewed, encompassing conference papers, reports, reviews, and research projects. The review examined the preparedness of the higher education sector to comprehend, and take advantage of, the differences between the 'physical vs. the digital, the sedentary vs. the nomadic' (Alexander, 2004). It sought to provide a pathway to what Salmon (2004) refers to as the 'fourth generation' of electronic learning environments, which in our view would incorporate the physical and the digital, the sedentary and the nomadic, and the online, the offline, and the wireless.

Rather than presenting a series of isolated case studies that may or may not be transferable from specific institutional settings to other learning and teaching contexts, the synthesis of the literature focuses on presenting a collection of visions for the development of m-learning approaches. Similarly, instead of offering generic perspectives for learning in a highly technological future environment, it seeks to synthesise the literature to identify a realistic vision for the application and implementation of embedded m-learning technologies as they become available.

### ***M-learning's opportunities and challenges: emerging themes***

Several key areas of m-learning theory, application and development were identified from the literature review. We introduce the changing dynamics of learners, institutions and ICTs to provide the context for the establishment of mobile learning, emphasising the drivers and motivations towards adoption, and identifying the systemic impediments towards reaching this goal; we further present some possible realistic visions for embedding mobile learning to engage learners in creative, collaborative, critical, and communicative activity, as well as the opportunities for m-learning implementation. Finally, we argue for the development of a holistic m-learning framework in which mobile and wireless technologies are efficiently and effectively employed to enhance learner capabilities. This is intended to establish the need for a formative framework that progresses past the individual case study to a consolidated approach.

### **The changing learning & teaching landscape**

Higher education institutions are confronted by considerable change driven by multiple external factors. Relevant to this review were the increasing tensions between the relative costs and benefits of the physical versus the virtual environments; the dramatic shifts in the characteristics of learners and how these shape the curriculum; and institutional strategy and policies. Blended learning environments that incorporate the physical and virtual are seen as critical strategies for higher education institutions. As summarised by McGovern and Gray (2005, p. 390), such environments have implications for learners (learning experience), teachers (practices), technology planning and sustainability. Within this context, the increasing availability of handheld and wireless devices prompts consideration of their application and benefit in the curriculum and whether this is marginal activity or 'core business.' The changing landscape is discussed in terms of changes relating to learners, institutions and the technologies.

### **Learner changes**

A constant exposure to digital technologies, gadgets, games, and mobile devices has arguably evolved a new breed of student, the 'natives': those learners who think and process information fundamentally differently from their predecessors, the 'immigrants', whose interaction with these tools is not innate. Prensky (2001) and several other authors have sought to describe the changes in learners in terms of generational differences, measuring such differences by the ease with which they adopt and adapt to new technologies. Oblinger (2003; 2004) considers the key traits of today's learners as being digitally literate, 'always on', mobile, experimental and community oriented. Characteristics of the 'millennial student' — those born from 1982 (Oblinger, 2003; Oblinger, 2004; Oblinger & Oblinger, 2005; McMahon & Pospisil, 2005; Jonas-Dwyer & Pospisil, 2004; Howe & Strauss, 2000; Poindexter, 2003; Raines, 2002) — are described as being focused on 'connectedness' and social interaction, and as having preference for group-based activities in

study and social occasions. Being in possession of an information technology mindset and a highly developed skill in multitasking (McMahon & Pospisil, 2005, p. 421), the millennial generation stays in contact through SMS, mobile phones, chatrooms, and email, whilst simultaneously playing computer games, listening to music, and watching television (Frاند, 2000, p. 18; Oblinger, 2003; Rickard & Oblinger, 2003). In their desire to be creative, to collaborate, and with this, to gain celebrity, today's learners are also seen to belong to 'Generation C' (Trendwatching.com, 2005). This trend indicates a movement towards the do-it-yourself (DIY) user-led creation of content. A new focus therefore forms on developing these capacities in the form of creative, collaborative, critical, and communicative responses. Thomas (2005) described the potential for institutions as 'pervasive learning', where a learner 'authors himself, in a location that the learner finds meaningful and relevant' (p. 1). The development of such pervasive learning models cannot be an end in itself, but is itself a response to learners' new ways of being.

### Technological changes

The changes in mobile and wireless ICTs for learning and teaching are extensive. The literature review considered the following options for m-learning: tablet PCs (Corlett & Sharples, 2004), iPods (Duke University, 2004; Perlman, 2005), palmtop computers (Savill-Smith & Kent, 2003), Personal Digital Assistants (PDAs) (Singh, Denoue, & Das, 2004; Squire, Johnson, Holland, Nataf, & Klopfer, 2002; Cochrane, 2005), mobile phones and SMS (Wagner, 2005; Cheung, 2004; Faulkner, 2004; Gonzales, Ittelson, & Krebs, 2004; Geddes, 2004; Mellow, 2005), and wireless infrastructure (Sotillo, 2003; Falk, 2003; Lu, Chun-Sheng, Chang, & Yao, 2003). Some devices (for example, mobile phones) have enjoyed extensive diffusion, whereas devices such as laptop computers have only recently reached the price point where they can reach critical mass for learners. The widespread availability of the technology is fundamental but by itself it is insufficient for effective learning environments. As suggested by Wagner (2005), 'The success of mobile learning will ultimately revolve around a mosaic of rich converged experiences' (p. 52). As we will show, this is also inextricably linked to changes in learners and their institutions.

In considering the implementation of mobile learning, Attewell (2005) suggests five broad categories of technology that should be considered, namely transport, platform, delivery, media technologies, and development languages, as seen in Figure 1.

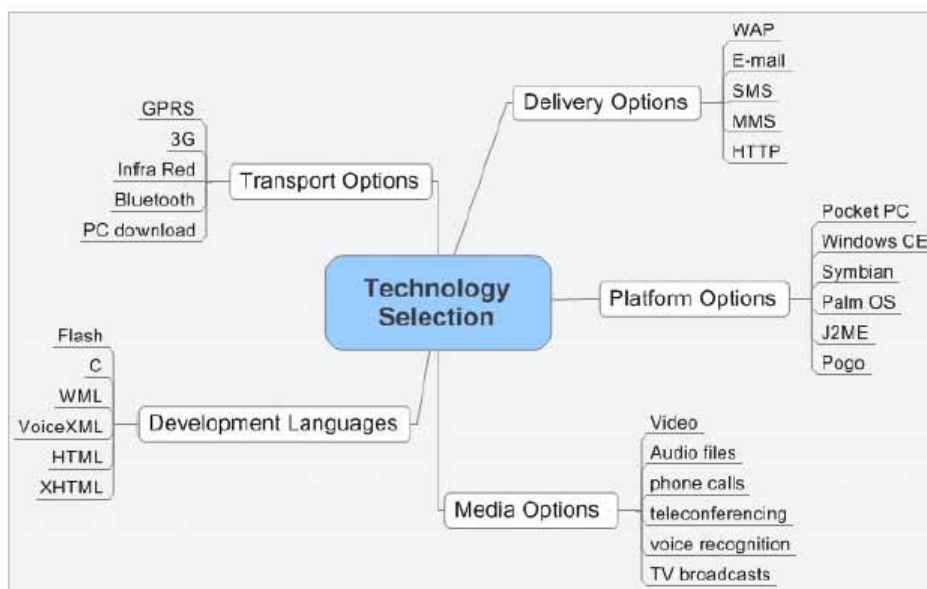


Figure 1: Technology selection (Attewell, 2005, p. 3)

## **Institutional changes**

Administrators and teaching staff within institutions are increasingly acknowledging and responding to external factors (such as competition, market trends and government policy imperatives) and internal factors (such as student preferences, staff capabilities, and pedagogical approaches). The changing costs of technology purchase and maintenance also mean that the provision of mobile and wireless access compares increasingly favourably with the maintenance of on-campus computer facilities, even if students are provided with subsidised or free hardware when they first enrol.

Beyond the financial bottom line, advances in ICTs influence the acquisition and management of knowledge and skills, and it is critical that institutions understand and respond to the learners' and staff's changing expectations and shifting capabilities. It is essential that the appropriate blends of campus-based experiences integrated with virtual learning be determined in order to facilitate efficient and effective student-centred learning. Agnes Kukulska-Hulme and John Traxler (2005) analysed a selection of international case studies to explore institutional motivations for undertaking m-learning projects. Their research reveals that the rationale for employing mobile technologies in teaching and learning relate principally to access, exploring changing trends in pedagogy, and alignment with institutional aims.

Bates and Poole (2003) propose a similar model for determining technology choices for effective learning and teaching in higher education; their criteria include appropriateness and access, ease of use and reliability, costs, teaching and learning approaches, interactivity, organisational issues, novelty, and speed. Whatever the list of criteria employed, an investigation of whether the right technology has been selected is arguably a key aspect of a comprehensive evaluation of mobile learning.

## ***Responding to systemic challenges***

Institutions need to manage adoption independent of specific models and types to conserve resources and minimise change fatigue. Similarly, institutions should note that ICT adoption is subject to the Gartner Hype Cycle (Linden & Fenn, 2003) and that infrastructure planning consequently warrants a strategic risk management approach. Selecting the appropriate technology infrastructure requires an assessment of the appropriateness, quality, compatibility and cost of the devices. Issues such as the management of learning through intermittent connections to institutional learning management systems (LMSs), in addition to maintaining device-independent delivery, pose significant obstacles to m-learning implementation.

As with all change management projects, gaining institutional support for the m-learning approach is critical. Areas to be addressed include cost, compatibility, equity of access, security, privacy and ethical concerns (Traxler & Bridges, 2004; Mobile Learning Group, 2004). In terms of application, issues including lack of teacher confidence, training, and technical difficulties with devices used may impact negatively on their uptake and use (Facer, Faux, & McFarlane, 2005).

Effective blended teaching and learning environments require the commitment to integrating ICTs for more than 'bolt-on' information provision to facilitate engagement, connection and to create a scholarly community of practice in which learners can participate flexibly. Online methods for learning and teaching need to be 'viewed as a new context for learning, not just as a tool' (Salmon, 2004, p. 17). The editors of *Mobile learning: A handbook for educators and trainers*, Agnes Kukulska-Hulme and John Traxler (2005), provide an impetus for educators, researchers, and policy makers to integrate evaluation and quality assurance into the development and implementations of m-learning technologies. They demonstrate that the design, planning, implementation, and evaluation of the use of mobile technologies must be integrated in order to be successful. When considering the implementation of mobile infrastructure, it must be conceded that m-learning will not suit all learners and every situation.

Mobile learning does, however, offer new solutions to traditionally problematic contexts of information delivery. A number of authors emphasise the opportunities of access afforded by mobile learning. The range of learners whose needs may be met by m-learning includes mature-aged, gifted, international and remote learners, as well as those with cognitive, behavioural

or social problems, or with physical or mental difficulties (Savill-Smith & Kent, 2003; Strom & Strom, 2002; Rodríguez, Nussbaum, Zurita, Rosas, & Lagos, 2001). Mobile devices can help improve literacy and numeracy skills; encourage independent and collaborative learning experiences; identify areas where learners need assistance and support; mitigate resistance using ICTs; engage reluctant learners; enable learners to remain more focused for longer periods and promote self-esteem and self-confidence (Attewell, 2005, pp. 13–15).

Educators will need to establish the contexts in which the use of mobile technologies is relevant. For example, significant social, economic, ethical and educational factors will influence the effective and efficient uptake of mobile technologies. Innovative tools need to be interpreted and used according to the environment in which they will operate, with the concession that they may have a major impact on transforming current cultures and practices.

### ***Realistic visions for m-learning***

#### **Social software, social networks: social construction of learning**

Learners inhabit a social, cultural, and technological environment, and their learning is a 'constructive process of acting within an environment and reflecting upon it' (Sharples, 2000, p. 4) where knowledge is constructed and shared as part of a social process (Johnson, Johnson, & Smith, 1991, p. 11). A social constructivist view of learning considers that students learn best when given the opportunity to learn skills and theories in the context in which they are used (Brown, Collins, & Duguid, 1989; Resnick, 1987; Soloway, Grant, Tinker, Roschelle, Mills, Resnick et al., 1999). Students then construct their interpretations of a subject and communicate those understandings to others (Gay, Stefanone, Grace-Martin, & Hembrooke, 2001). Mobile technologies, if employed effectively, can support social constructivist approaches to learning. Todd Bryant (2006) sees these technologies as tools to 'expand discussion beyond the classroom and provide new ways for students to collaborate and communicate within their class or around the world' (p. 61). Equally, the trend towards 'Web 2.0' (O'Reilly, 2005), the next iteration of the World Wide Web characterised by open communication and communities' interaction in the creation of content, is considered as a new wave of innovation for teaching and learning (Alexander, 2006).

Consequently, through the application of mobile technologies within the learning design, students can be further empowered to undertake 'user-led education,' creating their own content and collaborating with peers and communities within and beyond the classroom. Generation C (Trendwatching.com, 2005) operates and interacts well as a digital native in this domain. The involvement of the user in the development of content and institutions' increased interaction with community are now seen to harness the power of 'produsage' (Bruns, 2005a; 2005b), the 'collaborative and continuous building and extending of existing content in pursuit of further improvement' (Bruns, 2005b). Moreover, in offering flexibility, ubiquity of access to information, and motivating increased engagement, mobile technologies and infrastructure facilitate this revolution of 'always-on learning, accessible to the masses, but tailored to the individual' (Thomas, 2005, p. 5). Pervasive learning facilitated by mobile technologies offers flexibility to learners in terms of community, autonomy, locationality and relationality (Thomas, 2005, p. 2).

In terms of location, for example, mobile learners should have the option of choosing when and where they learn. This accrues the benefit of allowing learners to translate 'textbook' experience into knowledge apposite to the 'real world'. According to Mifsud (2003), following Soloway, Norris, Blumenfeld, Fishman and Marx (2001), flexible access to handheld technology will provide the tools to help learners construct knowledge throughout their daily activities, thereby making this technology an integral part of daily learning. Moreover, learning will increasingly occur in contexts outside the classroom (Lave & Wenger, 1991; Resnick, 1987), where the importance of community contexts becomes paramount (Sharples, 2000).

#### **Creative, collaborative, critical, and communicative engagement of learners**

Synthesis of the relevant literature confirms that mobile technologies are able to support learners' engagement in creative, collaborative, critical, and communicative learning activities, but considerable diversity was found in the ways teachers and learners have used digital and mobile technologies to support these real-world practices.

According to Loveless (2002, p. 4), the affordances of digital technologies are being exploited in processes such as developing ideas, making connections, creating and making, collaboration, and communication and evaluation.

Recent literature indicated that mobile and wireless technologies offer considerable benefits and affordances sympathetic to building and supporting creative, collaborative, critical, and communicative capacities within learning environments. Several authors refer to the capacity of mobile learning to enhance collaborative interactions and communities of practice (Cortez, Nussbaum, Santelices, Rodriguez, Zurita, Correa et al., 2004; Colley & Stead, 2004; Stead, 2005; Zurita, Nussbaum, & Sharples, 2003; Barker, Krull, & Mallison, 2005). Mobile technologies obviate the weaknesses of coordination, communication, organisation, negotiation, interactivity, and mobility encountered in collaborative learning undertaken without technology, as demonstrated by Zurita and Nussbaum (2004). Similarly, Naismith, Lonsdale, Vavoula and Sharples (2004) see the strength of mobile technology as providing a shared conversation space, given that 'effective learning occurs when people can converse with each other, by interrogating and sharing their descriptions of the world' (p. 27). The facilitation of improved communication and interaction between staff and students in the university environment via mobile technologies has also been considered by Beale and Jones (2004), McGovern and Gray (2005), and Field (2005) in the blended learning environment. The work of Divitini, Haugalokken and Norevik (2002, p. 1) explores the 'potentialities' of mobile technologies for coordination and communication and how they may be used for accessing timely information independent of place, new communication channels and facilitating peer and teacher communication.

## Conclusion

### *Towards an m-learning conceptual framework*

What is evident from the discussion above is the need for conceptual frameworks to guide the design of learning-centred educational environments that best exploit mobile and wireless devices. Boud and Prosser's (2002, pp. 240–241) broad framework for appraising learning activities using new technologies is useful to a discussion of what constitutes high-quality m-learning. The authors' framework refers to four key areas that are considered to be fundamental to enhancing the students' experiences of their learning activities in engaging learners, acknowledging the learning context, challenging learners, and providing practice.

In adhering to these principles of design, mobile technologies can contribute to quality learning experiences for students. M-learning could be instrumental in increasing learning flexibility by customising learning to be a more personalised and learner-centred activity (Leadbetter, 2005, cited in Sharples, Taylor, & Vavoula, 2005; Bull & Reid, 2003). Moreover, we propose that m-learning can support the social construction of knowledge amongst learners by enhancing their critical, creative, collaborative and communicative engagement within the sites of application of knowledge. By challenging learners to engage collaboratively in DIY, co-creation of content or game-playing, m-learning can also contribute to building distributed learning networks of diverse participants who are actively participating in creative activities, as well as critically reflecting on their own and others' practice.

While broad frameworks for e-learning provide some guidance for learning designers, the literature review indicated that there was little attention being paid to developing specific frameworks to support the design of mobile learning. An initial attempt offered by Sharples, Taylor and Vavoula (2005, p. 4) suggested that a theory of mobile learning should be assessed against the following criteria:

- Is it significantly different from current theories of classroom, workplace or lifelong learning?
- Does it account for the mobility of learners?
- Does it cover both formal and informal learning?
- Does it theorise learning as a constructive and social process?
- Does it analyse learning as a personal and situated activity mediated by technology?

A conceptual framework for the design of mobile learning should ensure the achievement of learner-centred, highly situated, personal and collaborative mobile learning (Naismith, Lonsdale, Vavoula, & Sharples, 2004, p. 36) while also providing educators with the ability to understand and respond to systemic challenges in offering a realistic vision for efficient and effective mobile learning and teaching. By considering learners' creative, collaborative, communicative, and critical engagement, such a framework could provide meaningful insight into the achievement of enhanced learner knowledge, skills, and attributes. A framework will also need to consider a range of contemporary options, encompassing mobile learning's ludic possibilities (Mitchell & Popat, 2003; Mitchell & Savill-Smith, 2004;), and engagement with distributed learning networks and remote communities (Hine, Rentoul, & Specht, 2003; Laroussi & Derycke, 2003; Viljoen, 2005).

A decisive element to consider for all aspects of m-learning development is the identification of the 'tipping point,' where the uptake of mobile and wireless technologies will gain a critical mass which compels institutions to adopt effective and efficient mobile learning plans and approaches. It is beyond this tipping point that the potential for pervasive and seamless m-learning pedagogical approaches will be realised for learners, teachers, and institutions. Finally, then, as we move towards that point, the philosophical underpinnings of such m-learning pedagogies will also need to be further developed.

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