British Journal of Educational Technology *Vol 45 No 1 2014* 65–82
doi:10.1111/j.1467-8535.2012.01384.x

Critical success factors for transforming pedagogy with mobile Web 2.0

Thomas Donald Cochrane

Thomas Donald Cochrane is an Academic Advisor in eLearning and learning technologies within the Centre for Learning And Teaching at AUT University, New Zealand. Address for correspondence: Dr Thomas Donald Cochrane, Centre for Learning and Teaching (CfLAT), AUT University, WY110, Wakefield St, Auckland 1010, New Zealand. Email: thomas.cochrane@aut.ac.nz

Abstract
Mobile learning (mlearning) research has in general been characterised by short-term comparative pilot studies with little high-level critique or theory formation. Consequently, there is limited evidence in the literature of mlearning research that is longitudinal across multiple contexts, cooperative and participatory. In response, this paper reflects upon longitudinal (2006–2011) participatory action research and identifies six critical success factors for implementing mobile Web 2.0. These are drawn from the design and implementation of over 35 projects from 2006 to 2011, exploring pedagogical transformation enabled by mobile Web 2.0 integration in higher education. Two of these critical success factors are highlighted in this paper: the need for new approaches to technical and pedagogical support, and the sustained interaction of supporting communities of practice.

Introduction

Mobile phone ownership has outpaced desktop and laptop computing ownership, marking their rise to almost ubiquitous ownership during 2009 (ITU, 2009). The introduction of the iPad in 2010 marked another wireless mobile computing revolution. During 2011/2012, smartphone ownership finally outnumbered basic cellphone ownership, making smartphones the most ubiquitous connected computing devices. The ubiquity and connectivity of these wireless mobile devices (WMDs) enable their use as disruptive devices to act as catalysts for pedagogical change moving from a focus upon teacher-delivered content or instruction to a focus upon designing collaborative learning activities or "what the student does" (Biggs, 1999, p. 57). Thus, the researcher has been interested in utilising mobile learning (mlearning) for mediating student-generated learning contexts and sharing student-generated content as key elements of social constructivist learning environments where students work in teams to create and critique knowledge construction guided by expert lecturers.

There has been considerable research on content delivery to mobile devices, short message service (SMS) and mobile application development for educational contexts (Frohberg, Goth & Schwabe, 2009). However, the majority of this research focuses upon teacher-delivered content rather than student-generated content. There has also been considerable research in the educational use of Web 2.0 (Hughes, 2009; Lee & McLoughlin, 2010), particularly for supporting student collaboration and social networking. However, there are relatively few examples of longitudinal research explicitly integrating mobile and Web 2.0 technologies for enabling social constructivist learning environments in higher education as recommended by Hoppe, Joiner,

Practitioner Notes

What is already known about this topic

- There is a growing body of literature around the use of mobile learning (mlearning) to bridge formal and informal learning.
- There has been significant exploration of Web 2.0 frameworks supporting social constructivism.
- There has been significant interest in communities of practice in higher education.

What this paper adds

- Reflections upon longitudinal action research in mlearning involving over 35 projects between 2006 and 2011, leading to the identification of six critical success factors.
- The paper expands upon two of these identified critical success factors for mobile Web 2.0 in education:
  1. The need for technological and pedagogical support for matching of the unique affordances of mobile Web 2.0 with social constructivist learning paradigms.
  2. The explicit scaffolding of the required ontological shifts in pedagogical transformation via a structured and sustained intentional community of practice model over a significant period of time.
- The paper provides a model of collaborative mlearning research that leverages partnerships between educational technology researchers and lecturers.

Implications for practice and/or policy

- The paper highlights the importance of scaffolding pedagogical change via communities of practice.
- The paper also highlights the need for new approaches to technical and pedagogical support.
- The paper presents the development of a community of practice framework for implementing mobile Web 2.0.

Milrad and Sharples (2003). In a review of 102 mlearning projects published between 2002 and 2007, Frohberg *et al* (2009) found that only 5% of these projects focused upon social learning, less than 4% required higher-level thinking, 89% targeted novice learners and only 10% facilitated user-generated content. Wingkvist and Ericsson identified a particular lack of action research methodologies (Wingkvist & Ericsson, 2009) within reported mlearning research. Mobile Web 2.0 utilises mobile-optimised Web 2.0 tools in a variety of ways, including as content creation tools for students' online e-portfolios, establishing digital identity and developing online social networks that can become key elements of graduate professional careers. WMDs can also be utilised as communication and collaboration tools using an increasing range of mobile-optimised social networking tools such as Twitter, Posterous and Google Plus. Thus, mlearning has moved beyond the realms of fantasy to become a viable platform for contextual learning that bridges formal and informal learning environments in and beyond the classroom; Traxler and Wishart (2011) explore a selection of examples.

Identifying the gaps

According to Cook (2009) and Sharples (2010), the development of mlearning research has been characterised by three general phases:

1. A focus upon devices (eg, Handheld Computers in Schools [Perry, 2003]).
2. A focus on learning outside the classroom (eg, MOBILearn [O'Malley *et al*, 2005]).
3. A focus on the mobility of the learner (eg, CONTSENS [Cook, 2010]).

Internationally, many early (pre-2005) mlearning studies were typically short-term pilot studies. In their summary of the scope of mlearning research, Traxler and Kukulska-Hulme's (2005) main critique of these early mlearning research projects was for a general lack of rigor in evaluation and epistemological underpinnings.

The researcher's review of the mlearning literature indicated several common shortcomings in the majority of mlearning research:

- A lack of explicit underlying pedagogical theory (Traxler & Kukulska-Hulme, 2005).
- A lack of transferable design frameworks (Armstrong *et al*, 2008; Sharples *et al*, 2009).
- A general lack of evaluation of the projects (Vavoula & Sharples, 2009).
- A lack of longitudinal studies (Traxler & Kukulska-Hulme, 2005).
- A lack of the importance of pedagogical integration, ie, aligning the unique affordances of mlearning with appropriate assessments or activities (Laurillard, 2007).
- A lack of explicit student and lecturer support and scaffolding (Attwell, 2007).
- A lack of awareness of the ontological shifts (Chi & Hausmann, 2003) required for both the learners' conception of learning and the lecturers' conception of teaching. Often "net generation" skills are assumed, and most of the case studies consist of lecturers who could be described as early technology adopters (Armstrong *et al*, 2008).

Much of the work that has been done in mlearning to date focuses almost exclusively on the affordances of the devices and how they can be used for communication, information retrieval or receiving teacher-generated content (a phase one approach). As noted by Rushby (2012), "The majority of these studies do not move us significantly beyond what is already known and widely published in the field" (p. 355). This is the result of the general focus of mlearning research upon short-term projects that explore mlearning mainly within informal learning contexts with little focus upon sustainable integration of mlearning into formal education contexts. The identified shortcomings can be addressed by the explicit planning and investigation of these issues within research project design, such as that called for by Reeves (2005) who recommends a rethink of educational technology research methodologies to include sustained collaborative partnerships between researchers and practitioners with a focus upon pedagogical transformation. Vavoula *et al* (2009) echo Reeves' concerns within the context of mlearning research. They call for mlearning research that is longitudinal across multiple contexts, cooperative and participatory. With notable exceptions (eg, mobile learning network [MoLeNET]), there are few examples of longitudinal mlearning research that lead to the development of transferable design principles. In response, the researcher used a participatory action research methodology throughout more than 35 mobile Web 2.0 projects (see Table 2). The aim of the research was to investigate the potential of mobile Web 2.0 tools to facilitate social constructivist learning across multiple learning contexts including the following: both formal and informal, geographically disperse, synchronously and asynchronously. While the affordances of devices are necessarily explored in this research, the researcher has gone beyond these low-level uses of devices to explore them as cognitive tools within a sound theoretical foundation of student-centred and authentic activities.

Research methodology

A participatory action research methodology (Swantz, 2008) was used throughout the mlearning projects from 2006 to 2011, with the goal of enabling pedagogical transformation within a variety of learning contexts. The research questions were the following:

1. What are the key factors in integrating WMDs within tertiary education courses?
2. What challenges/advantages to established pedagogies do these potentially disruptive technologies present?
3. To what extent can these WMDs be utilised to support learner interactivity, collaboration, communication, reflection and interest, and thus provide pedagogically rich learning environments that engage and motivate the learner?
4. To what extent can WMDs be used to harness the potential of current and emerging social constructivist e-learning tools?

In order to answer the research questions, a series of participatory action research mlearning projects were used. A common framework for each project was developed and iteratively refined, as outlined in Table 1.

Each mlearning project was conducted as a series of research cycles that then informed the subsequent projects. Data collection for each project involved preproject participant surveys, participant reflective rich-media journals via blogs and e-portfolios, followed by postproject surveys and focus groups. The survey questions and data collection methodologies underwent continual re-evaluation and modification as appropriate for each different course context, and in response to the rapid development of mobile devices and mobile social networks throughout the time span of the action research (2006 to the present). This allowed for the continual development and improvement of the projects based on the feedback from participants at regular points in the projects. Critical incidents included participant reflections, surveys and focus group discussions. Following this, the researcher and the course lecturers collaborated on critiquing each project implementation and modifying the following project. Each action research cycle involved

Table 1: Example of mlearning project framework

mLearning project stages	*Timeframe*	*Outcome*
Establish weekly COP with lecturers and technology steward. Establish support requirements. Completion of an initial survey that explores participants prior pedagogical beliefs and practice. Establish lecturer e-portfolios. Establish a collaborative research agenda and research questions and establish ethics consent procedures.	Semester 1	Staff reflect upon their prior pedagogical beliefs and practice. Staff share their current course outlines and assessment strategies for collaborative editing via Google Docs. Staff develop competency with mlearning. Staff explore mlearning pedagogies. Staff develop pedagogical mlearning activities based on social constructivist pedagogies.
mLearning projects with staff and students. Implementation of the mlearning activities within each course and assessment.	Semester 2	Students establish mlearning e-portfolios. Implementation of student team projects using mobile Web 2.0 tools. Facilitating social constructivist pedagogies and bridging learning contexts.
Lecturers publish and present case studies based on project implementation, these then inform the design of the following iteration of the project.	End of Semester 2 and beginning of following semester	Collaborative research writing based on prior and redeveloped course outlines and outcomes via Google Docs. Conference, journal publications and symposia presentations.

COP, community of practice

a series of research cycles that occurred throughout the project providing continuous feedback, reflection and modification of the research approach. The in-project feedback was facilitated by the following:

- The establishment of a weekly face-to-face community of practice (COP) facilitated by the researcher.
- Instant Messaging and Twitter for communication between the students and lecturers, students and the technology steward/researcher, and lecturers and the technology steward/researcher.
- Rich Site Summary (RSS) feeds from forums set up on the learning management system (LMS) (Moodle and Blackboard).
- RSS feeds from student blogs and online media hosting services.

As shown in Table 2, the mlearning projects encompassed a variety of tertiary courses, forming a series of case studies spanning from 1 to 4 years of implementation and refinement, initially utilising a range of institutionally loaned WMDs. Each project typically spanned at least a full semester, and participants were encouraged to use the supplied mobile devices as their own for the length of the project. The initial 12 projects (2206–2009) identified six critical success factors for mlearning integration, and the subsequent projects (2010–2011) tested and refined these. During 2011, the mlearning projects were extended to include international collaboration between six higher education institutions across five countries within the icollab11 project, where the majority of participants used student-owned devices. To date, the projects have totalled over 1000 participants.

The mobile Web 2.0 projects used a common methodology: marrying the mobility, connectivity, communication, content creation and context sensor affordances of mobile devices with the collaboration and sharing enabled by mobile-optimised Web 2.0 services. Figure 1 provides a representation of the developed mobile Web 2.0 framework used throughout the projects.

Learning activities and assessments were redesigned to facilitate student-generated content via their mobile devices within authentic learning contexts. These contexts were bridged by mobile Web 2.0 sharing of student-generated content published in their Web 2.0 portfolios made up of a mashup of web-based productivity, collaboration and communication tools with accounts created by each student who then invited their peers and lecturers into these spaces. These were collated for assessment by RSS feeds into the institutional LMS. As students created their own e-portfolios, they could continue to develop these beyond the end of their course of study. These mobile Web 2.0 affordances were used to enable new forms of social constructivist pedagogy within a variety of course contexts. The goal of the mobile Web 2.0 projects was to facilitate student-directed or negotiated learning, encapsulated in the concept of heutagogy (Blaschke, 2012; Hase & Kenyon, 2000; Luckin *et al*, 2010). For example,

- In 2009, the third year Product Design physical studio space was reinvented as a "Nomadic Studio," allowing students to link and share authentic experiences in the field with their peers and lecturers via mobile social networking (Cochrane, Bateman *et al*, 2009).
- In 2010, a second year Product Design project was redesigned from a focus upon paper-based student reports displayed in their studio space to students collaborated on designing sustainable food products with students in Ireland, communicating via Twitter and Skype (Cochrane, 2010d).
- In 2011, a third year Architecture elective course was redeveloped from teaching students to use Flash to create a CDROM-based Curriculum Vitae to an exploration of mobile Web 2.0, leading to student-generated projects. These projects involved students negotiating teams and assessment around mobile augmented reality projects, such as creating interactive layers of aspects of Architecture throughout their city (Cochrane & Rhodes, 2011).

Table 2: Summary of mobile Web 2.0 projects 2006–2011

Context	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Bachelor of Product Design (Cochrane & Bateman, 2011)	Palm Lifedrive $n = 20$	Student-owned laptops $n = 20$	Nokia N80 $n = 8$, N95 $n = 8$, Apple iPhone 3G $n = 12$	Nokia XM5800 $n = 30$, N97 $n = 8$	Student-owned devices $n = 35$	
Diploma of Landscape Design (Cochrane, 2009b)	Palm TX $n = 8$	Nokia N80 $n = 8$	Sony Ericsson P1i $n = 8$	Dell Mini9 netbooks $n = 20$		
Diploma of Contemporary Music (Cochrane, 2012a)			iPod Touch $n = 15$, iPhone 3G $n = 6$	iPhone 3G $n = 15$, iPod Touch $n = 15$	iPad1 $n = 15$	
Bachelor of Architecture (Cochrane & Rhodes, 2011)				Nokia XM5800 and Dell Mini9 $n = 130$	iPad1 and HTC Desire $n = 20$	iPad1 and iPhone4 $n = 20$
Bachelor of Performing and Screen Arts (Cochrane, 2012b)				Nokia XM5800 $n = 25$	Nokia N97 $n = 25$, Nokia XM5800 $n = 80$, Dell Mini9 $n = 120$	iPad1 and iPhone 3G $n = 25$
Accountancy Law and Finance (Oldfield, Cochrane & MacDonald, 2011)					iPad1 $n = 40$	iPad1 $n = 30$
Bachelor of Computing (Cochrane, 2012c)					iPhone 3G $n = 20$	
Bachelor of Graphics Design					Nokia XM5800 $n = 80$	
Bachelor of Civil Engineering (Cochrane, Narayan & Oldfield, 2011)					iPad1 $n = 15$	
Icollab11: Bachelor of Communications (Public Relations) (Cochrane, Bateman *et al*, 2011)						Student-owned devices $n = 140$
Bachelor of Communications (Journalism) (Cochrane, Sissons & Mulrennan, 2012)						Student-owned devices $n = 25$

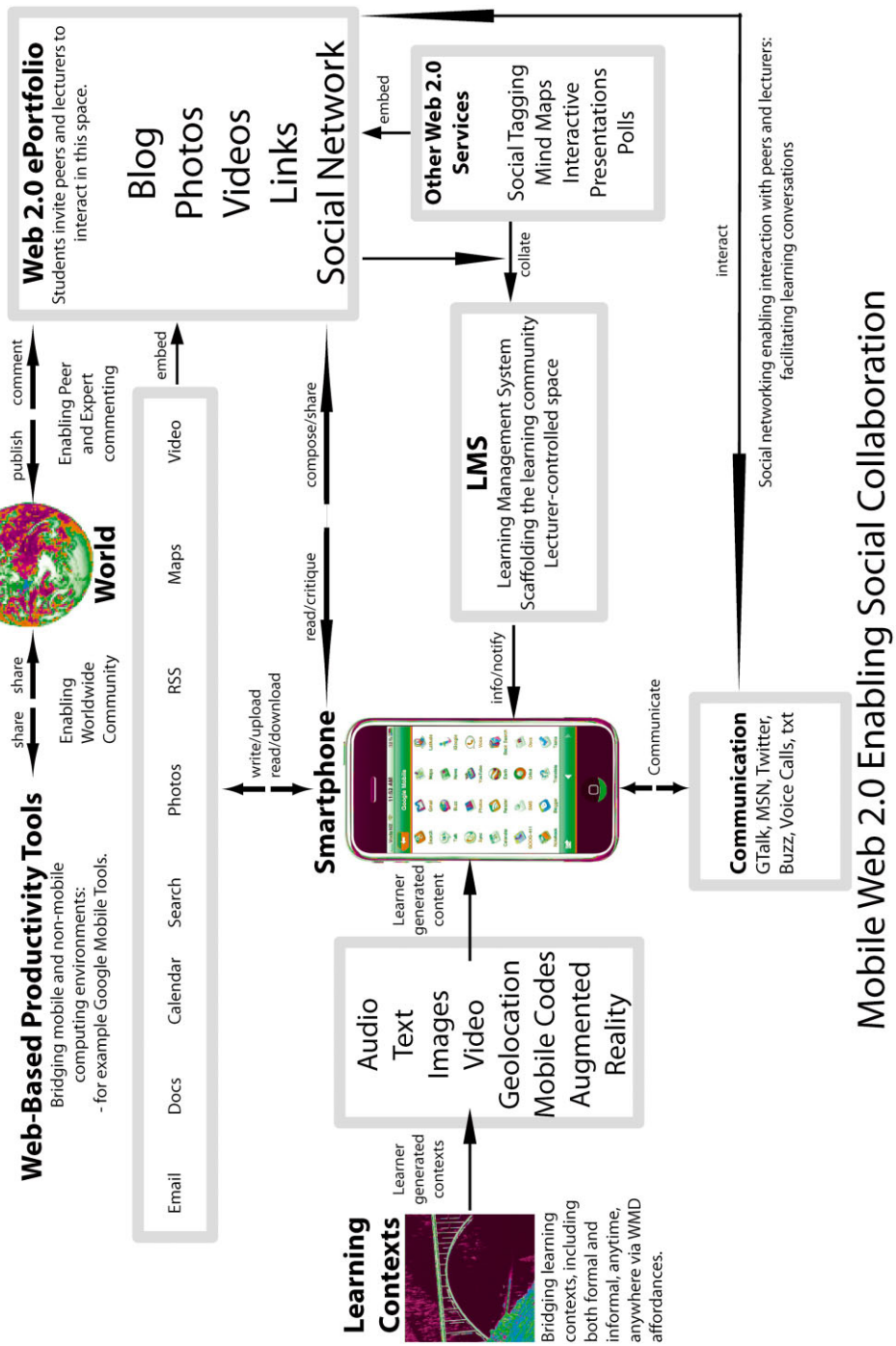

Figure 1: Mobile Web 2.0 framework

This approach required constant modification as mobile Web 2.0 services developed, shut down (eg, Vox), or new services (such as Twitter and Google Plus) became available. The researcher's role as technology steward for these projects was critical in guiding and scaffolding lecturers and students in this constantly changing environment (Cochrane, 2011).

Theoretical frameworks

Traxler and Kukulska-Hulme's (2005) critique of early mlearning research revealed a lack of explicit foundation on learning theory. Sharples, Taylor and Vavoula (2007) addressed this with their theory of mlearning that is effectively a synthesis of a conversational model and activity theory. However, the researcher agrees with Pachler, Bachmair and Cook's (2010) critique that activity theory is too object oriented and too difficult to operationalise in practice.

Therefore, social constructivism (Vygotsky, 1978) was chosen as the fundamental pedagogical theory for the research projects. Vygotsky (1978) postulated that we learn most effectively by being actively involved in knowledge construction in groups with guidance from more knowledgeable peers; this theory of learning has become known as social constructivism. Mobile devices are inherently social collaboration and communication devices that provide powerful tools for enabling social constructivist pedagogy. Thus, the projects focused upon student-generated content and collaboration rather than the delivery of teacher-generated content to mobile devices. In light of the lack of a widely accepted theoretical framework for mobile Web 2.0 (Pachler *et al*, 2010; Traxler & Kukulska-Hulme, 2005), four general pedagogical frameworks were chosen to guide the design and implementation of the research: COPs (Wenger, White & Smith, 2009), the Conversational Framework (Laurillard, 2007), Learner-Generated Contexts (Luckin *et al*, 2010) and Authentic Learning (Herrington & Herrington, 2007).

Lecturer professional development for engagement with mobile Web 2.0 was framed around the establishment of COPs, and each subsequent mobile Web 2.0 project was then framed around a COP of the participating lecturers, their students and the researcher. Wenger *et al*'s (2009) development of the role of the technology steward was taken on by the researcher to support the pedagogical integration of technology and this became a crucial element of the supporting COPs surrounding each mlearning project. The conversational framework guided the development of enhanced communication and collaboration between the students, lecturers and resources enabled by mobile devices. Luckin *et al*'s (2010) concept of the pedagogy-andragogy-heutagogy (PAH) continuum was used as a measure of the pedagogical transformation achieved in each mlearning project as the lecturers moved from pedagogy (teacher directed) to andragogy (student centred) to heutagogy (learner directed) (Blaschke, 2012). Authentic learning formed the framework for the design of student learning experiences, bridging situated contexts both in and beyond the classroom using mobile devices.

All four frameworks emphasise the critical element of starting with pedagogical design of learning activities and assessment (pedagogical integration) and were used to inform the research projects. Lecturer modelling, the establishment of a supportive learning community and the appropriate choice of technologies are addressed by all four frameworks. These frameworks informed the iterative development of over 35 mlearning projects between 2006 to 2011 (Table 2) forming the empirical basis of the research.

Critical success factors

Data analysis of participant feedback, surveys, focus groups and participant journals (blogs) from the initial mlearning projects between 2006 and 2009 identified six pedagogical critical success factors as emergent themes for mobile Web 2.0 integration (Cochrane, 2010b). Critical success factors were defined as those factors that were crucial to enabling significant pedagogical change within a course as a result of the implementation of the mlearning projects. The critical success

factors were identified as common themes from comparative analysis of the collated project data that included the following: preproject participant surveys (collated via Excel spreadsheets), participant blog posts throughout the projects (collated in Word documents), participant reflections in the form of VODCasts (collated in transcribed Word documents) and postproject participant surveys and focus groups (collated and graphically represented via Excel spreadsheets). These critical success factors were then tested in the following projects from 2010 to 2011. Each of the researcher's mobile Web 2.0 projects has highlighted the impact of combinations of these critical success factors. These identified critical success factors can be compared against similar success factors identified by other research projects such as Barker, Krull and Mallinson (2005), JISC (Knight, 2009) and the four supporting frameworks adopted by the research projects: COPs, Learner-Generated Contexts, Authentic Learning and the Conversational Framework. While each of these studies and frameworks emphasises different critical success factors for mlearning, in general they can be classified within the success factors identified across the researcher's mlearning projects, adding validity and rigour to these findings. The researcher's six critical success factors are listed below alongside the case studies that most clearly illustrated these (Cochrane, 2012b):

1. The pedagogical integration of the technology into the course and assessment. Identified in the 2006 Diploma of Landscape Architecture project (Cochrane, 2007a) and illustrated by the 2008 Bachelor of Product Design projects (Cochrane & Bateman, 2008).
2. Lecturer modelling of the pedagogical use of the tools. Identified by the 2008 Diploma of Landscape Architecture project and illustrated by the 2009 Architecture project (Cochrane & Rhodes, 2011).
3. Creating a supportive learning community. Identified in the 2006 projects (Cochrane, 2007b) and illustrated by the 2008–2009 Diploma of Contemporary Music project (Cochrane, 2009a).
4. Appropriate choice of mobile devices and Web 2.0 social software. Identified in the 2007 Landscape Architecture project and illustrated by the 2008 Landscape Architecture project (Cochrane, 2009c).
5. Technological and pedagogical support. Identified in the 2006 Bachelor of Product Design project (Cochrane, 2007a) and illustrated by the 2009 Bachelor of Performing and Screen Arts (PASA) project (Cochrane, 2010a).
6. Creating sustained interaction that facilitates the development of ontological shifts, both for the lecturers and the students. Illustrated by the 2009 Bachelor of Product Design projects (Cochrane, Flitta & Bateman, 2009).

Underlying all of the critical success factors is the researcher's sixth identified critical success factor "Sustained interaction facilitating ontological shifts." An ontological shift involves either a reassignment of understanding from one ontological category to another (radical conceptual change) or within a category (conceptual change) (Chi, 1992; Chi & Hausmann, 2003). Within the context of the research, this involved a reconceptualisation of the roles of teachers (from content deliverer to facilitator of authentic experience) and learners (from passive participant to active co-constructor of knowledge). Each mlearning project also represented a radical conceptual shift in the understanding of the affordances of mobile social media to augment traditional physical learning spaces and interaction. In these projects, mobile social media was reassigned from the category of a purely social tool for informal use into a powerful tool for enabling student-generated content and collaboration within student-generated learning contexts. Without these reconceptions, the mlearning projects invariably failed to produce any significant pedagogical change (Cochrane, 2012d).

The comparison of the critical success factors identified by previous researchers indicates that most mlearning research has been put into the area of pedagogical integration, with relatively

little focus on the aspects of technological and pedagogical support, and only a hint of the need for sustained interaction for teaching and learning reconceptualisations. The emphasis of these critical success factors is on how to use the technology within pedagogical contexts. These factors are about how to implement mlearning related to the curriculum content and assessment. These are crucial elements of pedagogical integration. In comparison, the researcher's mobile Web 2.0 projects highlight that this can only occur after lecturers are willing and empowered to engage with mobile Web 2.0 in their teaching practice. Therefore, lecturer professional development was found to be a key to enabling widespread adoption of mlearning (Cochrane, 2007b, 2009b, 2010a). The mobile Web 2.0 projects have shown that the process of getting lecturers to engage with mobile Web 2.0 is far from simple and can take a lot of effort around professional development, often requiring ontological shifts (Cochrane & Narayan, 2011; Oldfield & Cochrane, 2011). The researcher would suggest that the lack of emphasis in the mlearning research literature upon the time required for the ontological shifts that these disruptive technologies facilitate is because typically mlearning projects are short-term projects and do not look at the longitudinal impact of mlearning. There are exceptions and notable long-term mlearning projects have been established, eg, MoLeNET (Attewell, 2008). However, in general, these projects have not focused upon facilitating social constructivist pedagogy or sustainable adoption across a variety of learning contexts (Frohberg *et al*, 2009). The identified success factors include reference to the importance of lecturer modelling of the technologies, a focus upon facilitating collaboration and leveraging the unique affordances of WMDs including mobility and student-owned devices.

After a comparison with previously identified success factors (Cochrane, 2012b), the key contributions to mobile Web 2.0 critical success factors identified by this research include the following:

1. The need for technological and pedagogical support for matching of the unique affordances of mobile Web 2.0 with social constructivist learning paradigms.
2. The explicit scaffolding of the required ontological shifts in pedagogical transformation via a structured and sustained intentional COP model over a significant period of time.

The following sections further explore these two identified critical success factors.

Technical and pedagogical support

The research has shown that significant technical and pedagogical support is crucial for both the lecturers' and students' integration of mobile Web 2.0 (Cochrane & Bateman, 2011). Surveys of all the participants' previous usage of mobile and Web 2.0 technologies revealed that they were in general consumers of these technologies but very few were producers. The integration of mobile Web 2.0 within the courses disrupted both the lecturers' conception of teaching and the students' conception of learning, and these reconceptions required scaffolding via sustained interaction over time. The mobile Web 2.0 projects illustrated that longitudinal technological and pedagogical support was required during mobile Web 2.0 project planning (lecturer professional development) and during its implementation with students. A short series of introductory support workshops is unlikely to achieve this. The establishment of supportive learning communities in the form of intentional COPs was found to meet the need of this longitudinal support.

Initial pedagogical and technical support for each mobile Web 2.0 project began with the establishment of a lecturer COP, focusing upon investigating the pedagogical use of the tools and developing lecturer competency and personal appropriation of the tools. This usually involved the use of Google Docs for lecturers to upload and share their previous or current course outlines and assessment outlines with the researcher and the other COP participants to facilitate collaborative redesign of course activities and assessments using mobile Web 2.0. Lecturers were also expected to establish the use of mobile Web 2.0 e-portfolios to gain an understanding of the experience from a learner's perspective. This often led to critical incidents where lecturers began to grasp the

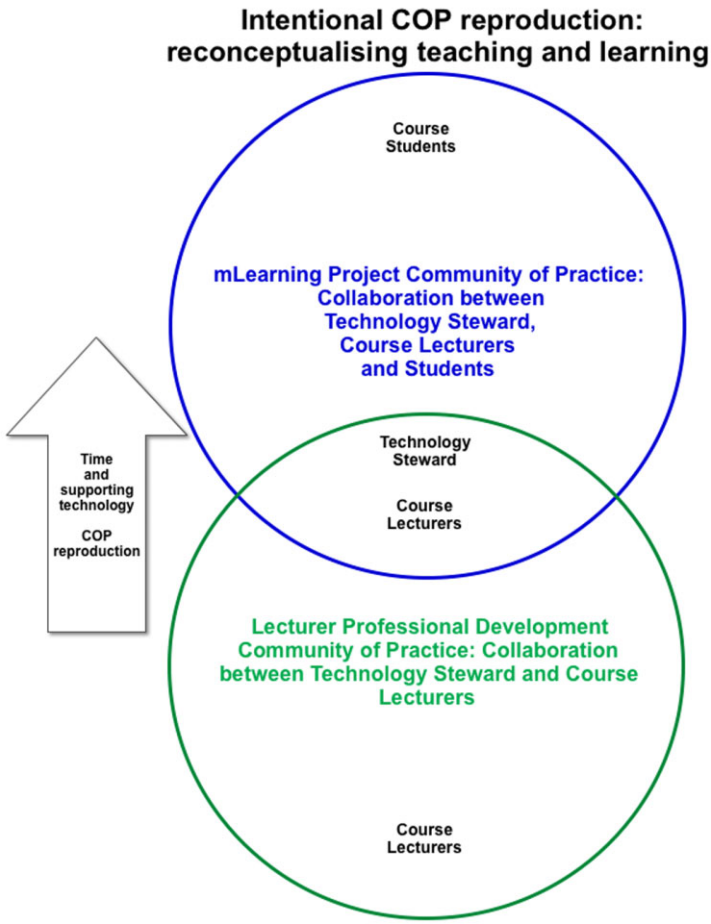

Figure 2: Intentional COP reproduction (COP, community of practice)

potential of these tools within their teaching practice (Cochrane, 2007b; Cochrane & Bateman, 2010; Cochrane & Flitta, 2009; Cochrane & Narayan, 2011). This was then followed by the establishment of a combined lecturer and student COP for implementing the mobile Web 2.0 project, reinventing traditional classroom interaction and redesigning established assessment activities. This in effect reproduced COPs brokered by the participation of the course lecturers and the researcher as the technology steward across both communities, as illustrated in Figure 2. The reified activities of these COPs in the form of participant-generated social media artefacts, such as YouTube videos, blog posts, Google Docs assessment outlines and Prezi presentations, were then used to broker the concepts and methodology as examples to other course contexts and leading to integration within the institution's wider e-learning strategy (Cochrane, 2010a; Cochrane & Narayan, 2011).

The projects highlighted the critical role of the "technology steward" to guide the integration of mobile Web 2.0 within the COPs. A strategy for pedagogical and technological support for the integration and implementation of mobile Web 2.0 was developed using an intentional COP model (Cochrane, 2007c, 2009b, 2010a). Wenger's (2005) definition of COPs "allows for, but does not assume, intentionality" (p. 1). While COPs often form organically and spontaneously, they can also be created intentionally and cultivated for specific purposes. Intentional COPs share

the same characteristics as organic COPs but have at their core a plan, as described by Langelier (2005). The concept of intentional COPs is similar to semi-formal learning communities (Kukulska-Hulme & Pettit, 2008) but was more longitudinal throughout the length of the mobile Web 2.0 projects. Using this model, the mobile Web 2.0 projects were guided and supported by regular weekly COP meetings facilitated by an appropriate technology steward who provided guidance to the group while also interacting as a peer group member in this learning community. These mobile Web 2.0 projects therefore become collaborative projects between the technology steward, the course lecturers (one of whom may take on the role of technology steward) and the students on the course. The institution's LMS was then used to provide administrative support for both lecturers and students. Lecturers were encouraged to model the use and integration of mobile Web 2.0 in their own daily workflows and to provide regular formative feedback to students via interaction on their Web 2.0 e-portfolios.

The role of the institutional LMS was changed in this approach (see Figure 1). The LMS was used to provide tutorials and initial guidance for students in setting up their Web 2.0 environments from the technology steward and the course lecturer. This inverted the normal learning space ownership paradigm, with the students then inviting the lecturer and technology steward to participate in their own learning spaces. The lecturer's role was to set guidelines and parameters around student learning space choices to make these manageable and appropriate collaborative learning spaces.

A limitation of the participatory action research methodology of the research was the significance of the input of the researcher as the technology steward for the projects. The researcher's mix of skills allowed him to provide the dual roles of both pedagogical and technological support. The partnerships developed between the researcher and the participants (particularly the lecturers) were critical in supporting and providing direction for the projects.

Creating sustained engagement facilitating ontological shifts

The mobile Web 2.0 projects illustrated that creating sustained engagement around the mobile Web 2.0 projects supported by COPs can facilitate ontological shifts among the participants. The mobile Web 2.0 projects identified two key issues around reconceptualising teaching and learning, representing ontological shifts in the participants' understanding:

1. Shifting lecturers from pedagogy to heutagogy, reconceptualising teaching as proposed by Luckin *et al* (2010) and McLoughlin and Lee (2008, 2010).
2. Shifting students beyond their previous experience, reconceptualising learning and using the WMDs to engage students via a focus upon student-generated content and student-generated contexts.

The integration of mobile Web 2.0 into their courses provided tools to facilitate collaborative projects in innovative and engaging ways. Both lecturers and students can struggle with the introduction of social constructivist pedagogies that shift the participants along the PAH continuum. The PAH continuum loosely aligns with the three stages of mlearning: beginning with a focus upon mobile Web 2.0 content (pedagogy), followed by exploring informal learning (andragogy) and then exploring student-generated contexts (heutagogy). A key strategy developed through the action research cycles to facilitate a move along the PAH continuum was staging and scaffolding the curriculum integration of mobile Web 2.0. Staging involves spreading the integration of mobile Web 2.0 across the length of a course and aligning the unique affordances of WMDs to the level of pedagogy at each stage, while scaffolding involves providing the support required for students to meet these goals. Staging and scaffolding the introduction of disruptive technologies via COPs maximise the effectiveness of the zone of proximal development. "Bridging the zone of proximinal development construct with legitimate peripheral participation construct

may be accomplished if one thinks of a zone in which the expert or mentor takes the learner from the peripheral status of knowing to a deeper status" (Attwell, 2006, p. 6). Thus, beginning the introduction of Web 2.0 integration into the first year of a course with a focus upon pedagogy and student-generated content will prepare students for the integration of both their formal and informal learning experiences via the unique context-bridging and social networking affordances of mobile Web 2.0, enabling a focus upon andragogy to heutagogy and student-generated contexts in subsequent years of their course.

For example, a PASA course has undergone significant transformation from previously paper-based student assessment portfolios and a teacher-directed lecture format:

- Instead of handing-in a paper-based journal at the end of the year, first year 2010 PASA students were introduced to establishing an online journal and e-portfolio of their course work for formative and summative assessment and peer critique, using mobile devices for blogging.
- In place of writing essays on the impact of mobile on the film industry, second year 2011 PASA students formed teams to create, share and critique their own mobile films (http://www.youtube.com/elvss11).
- Instead of a series of lectures by industry experts, third year 2012 PASA students participated in an authentic project involving global collaborative creation of mobile films by creating production teams across three countries enabled by mobile social networking (http://elvss2012.wordpress.com/).

Figure 3 provides a graphical representation of how the identified critical success factors combine to form the basis for facilitating ontological shifts, creating the foundation for lecturers to reconceptualise pedagogy and for learners to reconceptualise their role as learners becoming co-creators of content and situated learning contexts facilitated by the integration of WMDs.

Figure 3 illustrates that the sustained engagement of a supporting COP comprised a collaboration between the course students, the course lecturers and a technology steward, focusing upon scaffolding the pedagogical integration of WMDs, which creates the foundation for an ontological PAH shift among the participants.

Informing further research and practice

The use of an intentional COP model for the mobile Web 2.0 projects has created sustained engagement that has led to pedagogical transformation within a variety of higher education contexts. Table 2 shows only the projects that the researcher has been involved as the technology steward within these mobile Web 2.0 COPs. The reified activities of each mobile Web 2.0 COP have also created rich-media artefacts that have been used to broker the concept into establishing mobile Web 2.0 COPs in many more contexts than those shown. The focus of the 2011 mobile Web 2.0 projects moved from providing students with institutionally loaned WMDs to appropriating the affordances of student-owned devices. The concepts were also successfully brokered across a range of international collaborations in 2011 (Cochrane, Narayan *et al*, 2011) and 2012 (Cochrane, Antonczak & Wagner, 2012; Cochrane & Keegan, 2012). These two foci will drive further iterations of research and implementation.

Conclusions

The key contributions to mobile Web 2.0 of this research include the identification of the following two critical success factors—technological and pedagogical support—and the creation of sustained engagement facilitating ontological shifts for the participants. These two critical success factors are drawn from the researcher's experience of supporting the mobile Web 2.0 projects as the technology steward within intentional COPs throughout the length of the projects. As an integral member of these COPs, the researcher was able to provide targeted pedagogical

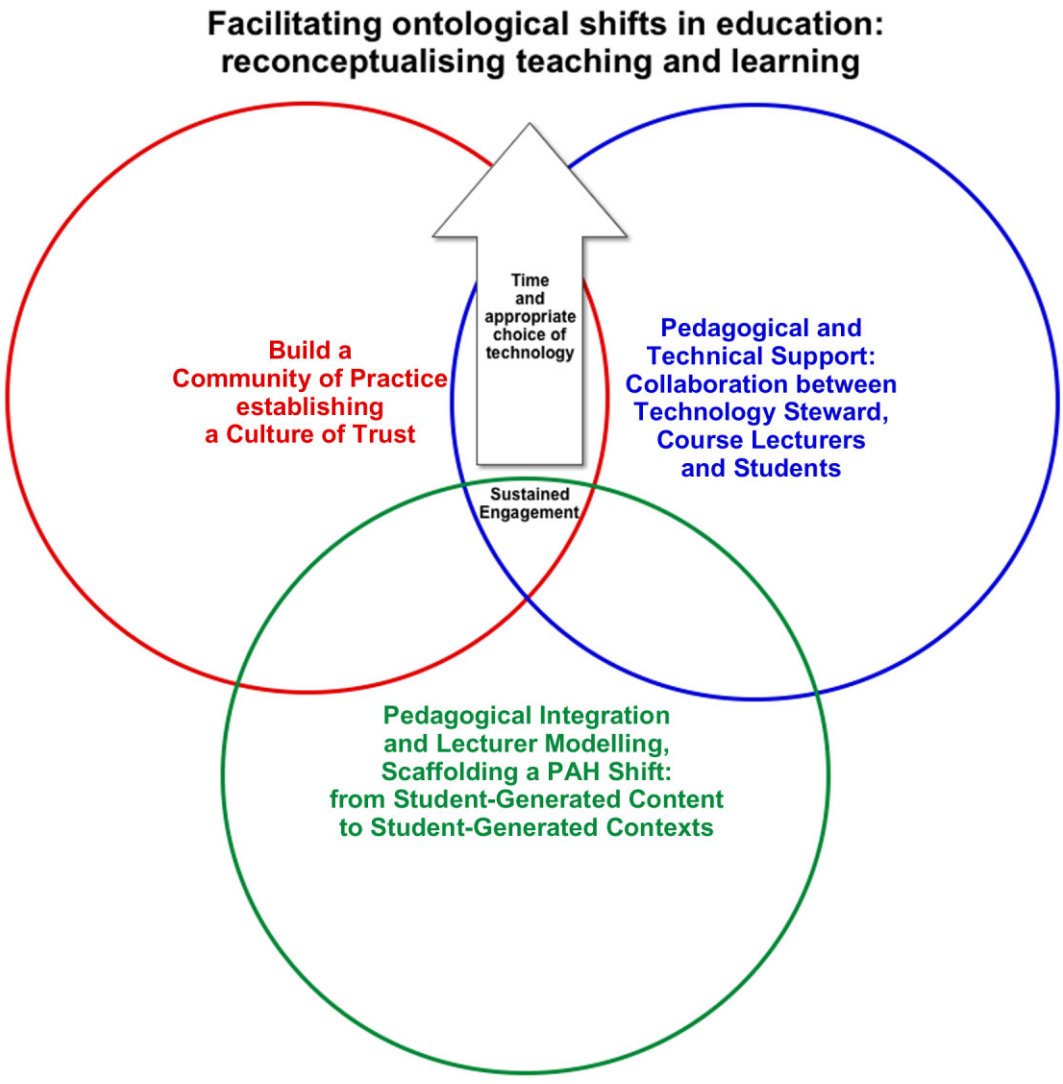

Figure 3: Critical success factors leading to ontological shifts (PAH, pedagogy-andragogy-heutagogy)

and technical support for the participants, and observe and identify critical incidents in the understanding of the participants. Strategies for reproducing COPs throughout an institution internationally have also been explored by the researcher (Cochrane, 2010a; Cochrane, Narayan *et al*, 2011). When combined (see Figure 3), the six critical success factors provide a foundation for facilitating ontological shifts within the participants. An intentional COP model provides a sustainable framework for pedagogical and technical support of mobile Web 2.0 projects. While it is time consuming, as Langelier (2005) emphasises: "The community of practice is one way to manage knowledge. It is a powerful, but demanding tool" (p. 8). However, the results are rich. The intentional COP model for supporting the mobile Web 2.0 projects has led to the development of mutually collaborative partnerships that have seen rewards in increased student engagement, deeper pedagogical reflection and practice-based research outputs. The symbiotic relationship developed between the researcher (as the technology steward) and the lecturers involved in each

of the mlearning projects has proven to be a vital partnership for harnessing mobile Web 2.0 technologies to design social constructivist learning environments in higher education.

References

Armstrong, J., Franklin, T., McLoughlin, C., Westera, W., Schmidt, P. & Kelly, B. (2008). *A review of current and developing international practice in the use of social networking (Web 2.0) in higher education*. York, UK: F. Consulting. Retrieved 11 May 2009, from http://www.franklin-consulting.co.uk/. . ./the%20use%20of%20social%20networking%20in%20HE.pdf

Attewell, J. (2008). Towards sustainable large scale implementation of mobile learning: the mobile learning network (MoLeNET). In J. Traxler, B. Riordan & C. Dennett (Eds), *MLearn08: the bridge from text to context* (pp. 28–35). Ironbridge Gorge, Shropshire, UK: University of Wolverhampton, School of Computing and IT.

Attwell, G. (2006). Personal learning environments. *The Wales-Wide Web*, 1 July 2006. Retrieved June 1, 2006, from http://www.knownet.com/writing/weblogs/Graham_Attwell/entries/6521819364

Attwell, G. (2007). The personal learning environments—the future of elearning? *Elearning Papers*, *2*, 1, 1–8.

Barker, A., Krull, G. & Mallinson, B. (2005). A proposed theoretical model for mlearning adoption in developing countries. In H. van der Merwe & T. Brown (Eds), *mLearn 2005: 4th World Conference on mLearning* (pp. 1–10). Cape Town, South Africa: mLearn.

Biggs, J. (1999). Teaching for enhanced learning. *Higher Education Research and Development*, *18*, 1, 57–75.

Blaschke, L. M. (2012). Heutagogy and lifelong learning: a review of heutagogical practice and self-determined learning. [Research Article]. *The International Review of Research in Open and Distance Learning*, *13*, 1, 56–71.

Chi, M. (1992). Conceptual change within and across ontological categories: examples from learning and discovery in science. In R. N. Giere (Ed.), *Cognitive models of science* Vol. 15 (pp. 129–186). Minneapolis: University of Minnesota Press.

Chi, M. & Hausmann, R. (2003). Do radical discoveries require ontological shifts? L. Shavinina & R. Sternberg (Eds), *International handbook on innovation* Vol. 3 (pp. 430–444). New York: Elsevier Science Ltd.

Cochrane, T. D. (2007a). Mobile Web2 pedagogies. In D. Parsons & H. Ryu (Eds), *Conference on Mobile Learning Technologies and Applications (MOLTA) 2007* (pp. 31–38). Auckland, New Zealand: Massey University.

Cochrane, T. D. (2007b). Moving mobile mainstream: using communities of practice to develop educational technology literacy in tertiary academics. In A. Norman & J. Pearce (Eds), *MLearn 2007—making the connections 6th International Conference on Mobile Learning* (pp. 37–45). Melbourne, Vic: Melbourne Exhibition Centre, University of Melbourne.

Cochrane, T. D. (2007c). Moving mobile mainstream: using communities of practice to develop educational technology literacy in tertiary academics. In C. Oliver (Ed.), *Proceedings of MLearn 2007—making the connections 6th International Conference on Mobile Learning* (pp. 35–42). Melbourne: Melbourne Exhibition Centre, MLearn.

Cochrane, T. D. (2009a). Contemporary music students and mobile technology. In J. O'Donoghue (Ed.), *Technology-supported environments for personalized learning: methods and case studies* (pp. 429–454). Hershey, PA: IGI Global.

Cochrane, T. D. (2009b). *Mobile web 2.0: from pilots to the mainstream*. Paper presented at the MLearn 2009: The 8th World Conference on Mobile and Contextual Learning, University of Central Florida, Institute for Simulation and Training, Orlando, Florida, 26–30 October.

Cochrane, T. D. (2009c). Mobilizing learning: intentional disruption. Harnessing the potential of social software tools in higher education using wireless mobile devices. *International Journal of Mobile Learning and Organisation*, *3*, 4(Special edition: Developing Themes in Mobile Learning), 399–419. doi: 10.1504/IJMLO.2009.027456.

Cochrane, T. D. (2010a). Beyond the Yellow Brick Road: mobile web 2.0 informing a new institutional elearning strategy. *Special Issue "The Transformational Impact of Learning Technology" of ALT-J, Research in Learning Technology*, *18*, 3, 221–231. doi: doi:10.1080/09687769.2010.529110.

Cochrane, T. D. (2010b). Exploring mobile learning success factors. *ALT-J, Research in Learning Technology*, *18*, 2, 133–148.

Cochrane, T. D. (2010c). *An mlearning journey: mobile web 2.0 critical success factors*. Paper presented at the MLearn 2010: The 9th International Conference on Mobile Learning, Valletta, Malta, 26–30 October.

Cochrane, T. D. (2010d). *Twitter tales: facilitating international collaboration with mobile web 2.0*. Paper presented at the Curriculum, technology & transformation for an unknown future. Proceedings

27th ASCILITE Conference, ASCILITE 2010, Novotel Sydney Brighton Beach, Sydney, Australia, 5–8 December.

Cochrane, T. D. (2011). Reflections on 4 years of mlearning implementation (2007–2010). [Journal]. *International Journal of Mobile and Blended Learning, 3*, 3, 1–22. doi: 10.4018/jmbl.2011070101.

Cochrane, T. D. (2012a). Contemporary music students and mobile technology. In Information Resources Management Association (Ed.), *Wireless technologies: concepts, methodologies, tools and applications* Vol. 3 (pp. 1390–1414). Hershey, PA: IGI Global.

Cochrane, T. D. (2012b). An mlearning journey: mobile web 2.0 critical success factors. *International Journal of Handheld Computing Research (IJHCR), 3*, 2, 44–57. doi: 10.4018/jhcr.2012040103.

Cochrane, T. D. (2012c). Mobile cloud services as catalysts for pedagogical change. In L. Chao (Ed.), *Cloud computing for teaching and learning* (pp. 164–184). Hershey, PA: IGI Global.

Cochrane, T. D. (2012d). Secrets of mlearning failures: Confronting reality. In S. Verjans (Ed.), *Proceedings of ALT-C 2012—a confrontation with reality: The 19th international conference of the Association for Learning Technology* (pp. 123–134). University of Manchester, UK: ALT Association for Learning Technology.

Cochrane, T. D., Antonczak, L. & Wagner, D. (2012). Heutagogial approaches to mlearning: from student-generated content to international co-production. In J. Multisilta (Ed.), *Mlearn 2012: the 11th World Conference on Mobile and Contextual Learning* (Accepted) (in pre-print). Helsinki, Finland: IAmLearn.

Cochrane, T. D. & Bateman, R. (2008). *Engaging students with mobile web 2.0*. Paper presented at the EIT Teaching & Learning Conference, EIT, Napier, New Zealand, 1–3 October.

Cochrane, T. D. & Bateman, R. (2010). *A mobile learning journey: or "a tale of two academics pedagogical partnership"*. Paper presented at the The 6th International Conference on Technology, Knowledge and Society 2010, Free University, Berlin, Germany, 15–17 January. Virtual retrieved 15 March 2010, from http://t10.cgpublisher.com/proposals/89/index_html

Cochrane, T. D. & Bateman, R. (2011). Strategies for mlearning integration: evaluating a case study of staging and scaffolding mlearning integration across a three-year bachelor's degree. *Waikato Journal of Education (WJE), 16*, 1, 109–124.

Cochrane, T. D., Bateman, R., Buchem, I., Camacho, M., Gordon, A. & Keegan, H. (2011). Mlearning 2.0: fostering international collaboration. In I. Candel Torres, L. Gomez Chova & A. Lopez Martinez (Eds), *ICERI2011: 4th International Conference of Education, Research and Innovations* (pp. 42–51). Madrid, Spain: IATED.

Cochrane, T. D., Bateman, R., Cliffin, P., Gardner, J., Henderson, I. & Holloway, S. (2009). *Mobilizing learning: mobile web 2.0 scenarios in tertiary education*. Paper presented at the EDULEARN09 the 1st International Conference on Education and New Learning Technologies, Barcelona, Spain, 6–8 July.

Cochrane, T. D. & Flitta, I. (2009). *An mlearning journey: critical incidents in transforming pedagogy*. Paper presented at the International Conference of Education, Research and Innovation (ICERI2009), Madrid, Spain, 16–18 November.

Cochrane, T. D., Flitta, I. & Bateman, R. (2009). Facilitating social constructivist learning environments for product design students using social software (web2) and wireless mobile devices. [Journal]. *DESIGN Principles and Practices: An International Journal, 3*, 1, 67–88.

Cochrane, T., & Keegan, H. (2012, 18–21 October). New global learning cultures: Interdisciplinarity through networked learning. *Internet Research 13.0: Technologies* Retrieved 13 October, 2012, from https://www.conftool.com/aoir-ir13/index.php?page=browseSessions&search=381

Cochrane, T. D. & Narayan, V. (2011). DeFrosting professional development: reconceptualising teaching using social learning technologies. In D. Hawkridge, K. Ng & S. Verjans (Eds), *Proceedings of ALT-C 2011—thriving in a colder and more challenging climate: the 18th International Conference of the Association for Learning Technology* (pp. 158–169). Leeds, UK: University of Leeds, ALT Association for Learning Technology.

Cochrane, T. D., Narayan, V. & Oldfield, J. (2011). iPadagogy: appropriating the iPad within pedagogical contexts. In S. Yu (Ed.), *mLearn2011, 10th World Conference on Mobile and Contextual Learning* (pp. 146–154). Beijing, China: Beijing Normal University.

Cochrane, T. D. & Rhodes, D. (2011). iArchi[tech]ture: heutagogical approaches to education facilitated by mlearning integration. In K. Fernstrom & C. Tsolakidis (Eds), *Proceedings of the International Conference on Information and Communication Technologies in Education ICICTE 2011* (pp. 112–121). Rhodes, Greece: Rodos Palace Hotel, University of the Fraser Valley and the University of the Aegean.

Cochrane, T. D., Sissons, H. & Mulrennan, D. (2012). Journalism 2.0: exploring the impact of mobile and social media on journalism education. In I. A. Sánchez & P. Isaias (Eds), *Proceedings of the IADIS International Conference on Mobile Learning 2012* (pp. 165–172). Berlin, Germany: IADIS International Association for Development of the Information Society.

Cook, J. (2009). Phases of mobile learning. *Joint European summer school on technology enhanced learning*, May 30–June 6. Retrieved 16 July 2010, from http://www.slideshare.net/johnnigelcook/cook-phases-of-mobile-learning

Cook, J. (2010). *Mobile phones as mediating tools within augmented contexts for development*. Paper presented at the Education in the Wild, Alpine Rendez-Vous, within the tramework of the STELLAR network of excellence, Garmisch-Partenkirchen, Bavaria, Germany, 3–4 December 2009. Retrieved 15 July 2010, from http://www.slideshare.net/johnnigelcook/cook-mobile-phones-as-mediating-tools-within-augmented-contexts-for-development

Frohberg, D., Goth, C. & Schwabe, G. (2009). Mobile learning projects—a critical analysis of the state of the art. [Research article]. *Journal of Computer Assisted Learning*, *25*, 4, 307–331. doi: 10.1111/j.1365-2729.2009.00315.x.

Hase, S., & Kenyon, C. (2000). From Andragogy to Heutagogy. *ultiBASE Articles*, (December), 1–10. Retrieved from http://ultibase.rmit.edu.au/Articles/dec00/hase2.htm

Herrington, A. & Herrington, J. (2007). *Authentic mobile learning in higher education*. Paper presented at the AARE 2007 International Educational Research Conference, Fremantle, Australia. Retrieved 12 February 2009, from http://www.aare.edu.au/07pap/abs07.htm

Hoppe, H. U., Joiner, R., Milrad, M., & Sharples, M. (2003). Guest editorial: Wireless and mobile technologies in education. *Journal of Computer Assisted Learning, 19*, 3, 255–259.

Hughes, A. (2009). *Higher education in a web 2.0 world*. Bristol: JISC. Retrieved 14 March 2009, from http://www.jisc.ac.uk/publications/documents/heweb2.aspx

ITU (2009). *The world in 2009: ICT facts and figures*. Geneva: ITU. Retrieved 10 October 2009, from http://www.itu.int/ITU-D/ict/material/Telecom09_flyer.pdf

Knight, S. (2009). *Effective practice in a digital age*. Bristol: JISC. Retrieved 1 August 2009, from http://www.jisc.ac.uk/publications/documents/effectivepracticedigitalage.aspx

Kukulska-Hulme, A. & Pettit, J. (2008). Semi-formal learning communities for professional development in mobile learning. *Journal of Computing in Higher Education*, *20*, 2, 35–47.

Langelier, L. (2005). *Working, learning and collaborating in a network: guide to the implementation and leadership of intentional communities of practice*. Quebec City: CEFRIO. Retrieved 27 May 2007, from http://www.cefrio.qc.ca/fileadmin/documents/Projets/GuideCommunautes.pdf

Laurillard, D. (2007). Pedagogcal forms of mobile learning: framing research questions. In N. Pachler (Ed.), *Mobile learning: towards a research agenda* (pp. 33–54). London: WLE Centre, Institute of Education.

Lee, M. & McLoughlin, C. (Eds) (2010). *Web 2.0-based e-learning: applying social informatics for tertiary teaching*. Hershey, PA: IGI Global.

Luckin, R., Clark, W., Garnett, F., Whitworth, A., Akass, J. & Cook, J. (2010). Learner-generated contexts: a framework to support the effective use of technology for learning. In M. Lee & C. McLoughlin (Eds), *Web 2.0-based e-learning: applying social informatics for tertiary teaching* (pp. 70–84). Hershey, PA: IGI Global.

McLoughlin, C. & Lee, M. (2008). Mapping the digital terrain: new media and social software as catalysts for pedagogical change. In A. Farley & D. Holt (Eds), *Proceedings of ASCILITE 2008* (pp. 641–652). Melbourne, Australia: Deakin University, ASCILITE.

McLoughlin, C. & Lee, M. (2010). Pedagogy 2.0: critical challenges and responses to web 2.0 and social software in tertiary teaching. In M. Lee & C. McLoughlin (Eds), *Web 2.0-based e-learning: applying social informatics for tertiary teaching* (pp. 46–69). Hershey, PA: IGI Global.

Oldfield, J. & Cochrane, T. D. (2011). Equipping lecturers for the iRevolution. In G. Williams, P. Statham, N. Brown & B. Cleland (Eds), *Proceedings of the 28th ASCILITE Conference, ASCILITE 2011: changing demands, changing directions* (pp. 919–929). Hobart, Tasmania, Australia: The University of Tasmania.

Oldfield, J., Cochrane, T. D. & MacDonald, D. (2011). *Making the "Case" for the iPad*. Paper presented at the International Conference on Elearning Futures (iCELF), Unitec, Auckland, New Zealand, 30 November to 1 December. Retrieved 10 December 2011, from http://www.icelf.org/assets/elc11Abstract00038.pdf

O'Malley, C., Vavoula, G., Glew, J., Taylor, J., Sharples, M. & Lefrere, P. (2005). MOBIlearn: D4.1 guidelines for learning/teaching/tutoring in a mobile environment. Retrieved February, 2007, from http://kn.open.ac.uk/public/document.cfm?docid=7232

Pachler, N., Bachmair, B. & Cook, J. (2010). *Mobile learning: structures, agency, practices*. London: Springer.

Perry, D. (2003). Handheld computers (PDAs) in schools. Retrieved 10 October 2006, from http://partners.becta.org.uk/index.php?section=rh&rid=13623

Reeves, T. (2005). No significant differences revisited: a historical perspective on the research informing contemporary online learning. In G. Kearsley (Ed.), *Online learning: personal reflections on the transformation of education* (pp. 299–308). Englewood Cliffs, NJ: Educational Technology Publications.

Rushby, N. (2012). Editorial: an agenda for mobile learning. *British Journal of Educational Technology*, *43*, 3, 355–356. doi: 10.1111/j.1467-8535.2012.01313.x.

Sharples, M. (2010). *Innovation in mlearning: an international perspective*. Paper presented at the mLearnCon, Sna Diego, California, 15–17 June. Retrieved 1 July 2010, from http://www.elearningguild.com/mLearnCon/concurrent-sessions/session-details.cfm?event=62&date=06/15/2010&time=10:45:00#2425

Sharples, M., Crook, C., Jones, I., Kay, D., Chowcat, I. & Balmer, K. (2009). *CAPITAL year one final report*. Becta. Retrieved 1 November 2009, from http://www.htcapital.info/

Sharples, M., Taylor, J. & Vavoula, G. (2007). A theory of learning for the mobile age. In K. Littleton & P. Light (Eds), *The SAGE handbook of e-learning research* (pp. 221–247). London: Sage.

Swantz, M. L. (2008). Participatory action research as practice. In P. Reason & H. Bradbury (Eds), *The SAGE handbook of action research: participative inquiry and practice* (2nd ed.). (pp. 31–48). London: SAGE Publications.

Traxler, J. & Kukulska-Hulme, A. (2005). *Evaluating mobile learning: reflections on current practice*. Paper presented at the mLearn 2005, Cape Town, 25–28 October.

Traxler, J. & Wishart, J. (Eds) (2011). *Making mobile learning work: case studies of practice*. Bristol: ESCalate, University of Bristol, Graduate School of Education.

Vavoula, G., Pachler, N. & Kukulska-Hulme, A. (Eds) (2009). *Researching mobile learning*. Bern: Peter Lang.

Vavoula, G. & Sharples, M. (2009). Meeting the challenges in evaluating mobile learning: a 3-level evaluation framework. *International Journal of Mobile and Blended Learning, 1*, 2, 54–75.

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wenger, E. (2005). Communities of practice: a brief introduction. (17 July). Retrieved 14 October 2006, from http://www.ewenger.com/theory/index.htm

Wenger, E., White, N. & Smith, J. (2009). *Digital habitats: stewarding technology for communities*. Portland, Oregon: CPsquare.

Wingkvist, A. & Ericsson, M. (2009). Current practice in mobile learning: a survey of research method and purpose. In D. Metcalf, A. Hamilton & C. Graffeo (Eds), *MLearn 2009: 8th World Conference on Mobile and Contextual Learning* (pp. 103–111). Orlando, FL: The University of Central Florida.