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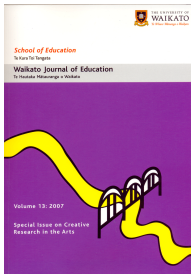

Strategies for mLearning Integration: Evaluating a Case Study of Staging and Scaffolding mLearning Integration across a Three-Year Bachelor's Degree

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Abstract

This paper outlines the third iteration of integrating mobile Web 2.0 within a Bachelor's level course. An analysis and comparison of the impact of mobile Web 2.0 across all three years of the 2009 course enables the development of implementation strategies that can be used to integrate mLearning into other tertiary courses, and inform the design of further Product Design mLearning integration iterations.

Keywords

mLearning, integration, scaffolding, tertiary

Introduction

The integration of mLearning across the 2009 Bachelor of Product Design programme was the result of the third iteration and refinement of a participatory action research project investigating the potential of mobile Web 2.0 in tertiary education. What began as an investigation of the affordances of Web 2.0 in 2007 developed into a mobile Web 2.0 proof of concept project within the third year of the Bachelor of Product Design in 2008, then quickly spread to projects within the first and second year of the programme in semester two of 2008. The success of these projects led to the integration of mobile Web 2.0 technologies based on an explicit social constructivist pedagogy across all three years of the programme in 2009 (See http://www.youtube.com/-watch?v=8Eh5ktXMji8 for an overview). The aforementioned projects formed one case study of a wider mLearning research project spanning 2007 to 2009 involving multiple course contexts. The mLearning projects encompassed five different tertiary courses, forming five core case studies spanning from one to three years of implementation and refinement, and involved a total of 280 participants using a variety of institutionally loaned Wireless Mobile Devices or WMDs. The learning contexts included: Bachelor of Product Design (2006 using Palm Lifedrive, 2008 using Nokia N80, N95, 2009 using

Nokia XM5800, N95, N97), Diploma of Landscape Design (2006 Using Palm TX, 2007 using Nokia N80, 2008 using Sonyericsson P1i, 2009 using Dell mini9 netbook), Diploma of Contemporary Music (2008, 2009 using iPod Touch, iPhone 3G), Bachelor of Architecture (2009, using Nokia XM5800 and Dell Mini9 netbook), and the Bachelor of Performing and Screen Arts (2009 using Dell Mini9 netbook and Nokia XM5800).

The Product Design course aims to develop graduates capable of creative and innovative design across a range of fields, with a specialization in furniture and sustainable design. Design education is traditionally modelled upon an atelier studio-based approach where students work in physical group spaces, guided by an expert lecturer, and culminating in face-to-face presentations of their designs critiqued by their lecturers. In this paper we investigate the potential for transforming the traditional physical studio-based design learning environment into a context-bridging social constructivist model by the integration of mobile Web 2.0 tools. The goal is to facilitate a progression from teacher-directed pedagogy in first year to student-centred andragogy in the second year, and then to student-directed heutagogy in the third year of the course, involving a collaborative, flexible, context-bridging learning environment that empowers students as content producers and learning context generators, guided by lecturers who effectively model the use of the technology. This move from pedagogy to heutagogy across the three years of the programme required scaffolding the learners via a supportive community of practice (COP) with the researcher taking on the role of a technology steward (Wenger, White, & Smith, 2009; Wenger, White, Smith, & Rowe, 2005), facilitating the three COPs across each year of the course. In the first year of the course, students and lecturers create an online digital identity, begin developing an eportfolio, and establish the basis of a potentially life-long international peer and professional support network, including blogs, social networks, location aware (geotagged) image and video sharing, and instant messaging. In the second year the course was modified to leverage the unique affordances of mobile Web 2.0 tools such as microblogging, mobile video streaming, and augmented reality. In their final year students then use these tools to create learner-generated contexts involving a major student-negotiated design project that effectively bridged the formal learning environment of the design studio and the informal learning environments of situated authentic practice. Brown (2006) calls this “Dewey for the digital age”.

> … a profoundly social construction of understanding enabled by the Internet. The demand-pull approach draws students into a rich (sometimes virtual) learning community built around a practice. It is passion-based learning, intrinsically motivated by either wanting to become a member of that community of practice or just wanting to learn about, make, or perform something. Formal or informal, learning happens in part through a kind of reflective practicum, but here the reflection comes from being embedded in a social milieu supported by both a physical and virtual presence and inhabited by both amateurs and professionals. … Social software enables communities to form and find each other, to learn through remixing, tinkering, and sharing artifacts using the rich media now available. (Brown, 2006, pp. 23–24)

Methodology

The research used a participatory action research methodology (McLoughlin & Lee, 2007; Wadsworth, 1998), and based its pedagogical decisions upon the foundation of social constructivist learning theories, with a focus upon facilitating student-generated content and student-generated learning contexts. In the 2008 and 2009 Product Design mLearning projects students and lecturers were provided with institutionally owned WMDs. A WMD choice rubric was developed by the researcher based upon 16 identified mobile affordances to make an informed choice of appropriate WMDs for each project. Students and lecturers were encouraged to personalise the use of these mobile devices and treat them as if they owned them for the duration of the year. The goal was to provide proof of concept of the impact of the integration of mobile Web 2.0 into the course, before moving to a student-owned WMD implementation beginning in 2010. The projects began with the formation of a weekly one-hour lecturer community of practice investigating the potential pedagogical impact of mLearning on their courses. This same COP model was then used to support the implementation of mLearning within the courses involving three COPs of the students and lecturers in each of the three year groups of the course. Course lecturers were asked to reflect on the impact of mobile Web 2.0 at several points throughout the projects, and used a variety of media to capture their reflections, including posts to their blogs, VODCasts (video recordings uploaded to their blogs and YouTube), paper surveys, discussions and brainstorms with the researcher. Lecturer reflections were focused on the aspect of pedagogical transformation. Students were also asked to record (as VODCasts) their reflections on the project at the middle and the end of each project. These were then transcribed and collated by the researcher for identifying emergent themes.

Research Questions

The research questions were

- What are the key factors when integrating Wireless Mobile Devices (WMDs) within tertiary education courses?
- What challenges/advantages to established pedagogies do these disruptive technologies present?
- To what extent can WMDs be utilized to support learner interactivity, collaboration, communication, reflection and interest, and thus provide pedagogically rich learning environments that engage and motivate the learner?
- To what extent can WMDs be used to harness the potential of current and emerging social constructivist e-learning tools?

Pre-trial surveys captured the participants' previous mobile Web 2.0 experiences. Throughout the duration of the project, lecturers and students attended a weekly community of practice (COP) to investigate and support the integration of mobile Web 2.0 tools into their courses. Observations of critical incidents emerging during these COPs were recorded by the researcher in a weekly research journal. Participant feedback was captured via RSS feeds collated using Google Reader from participants' online Web 2.0 sites, including a blog and eportfolio consisting of a variety of participant Web 2.0 accounts including YouTube, Picasaweb, Prezi, and Qik. A post-trial survey and focus group discussion were also used to capture participant feedback.

Participant surveys were collated using Excel spreadsheets and qualitative data was collated and analysed for emergent themes by the researcher.

Project Pedagogical Development

In 2007 the third year Product Design lecturer enlisted the help of the researcher to integrate the use of student eportfolios into the course in the form of student-created blogs. The Web 2.0 blogging project effectively replaced the previously utilized paper-based student portfolios that were used for third year student assessment.

In 2008 a collaborative project between the third year Product Design lecturer and the researcher was developed to trial the integration of mLearning into the course alongside the continued integration of student blogs as core eportfolios. Nine third year students volunteered to participate in this project. They committed to participating in a weekly one-hour community of practice supporting the project and were supplied with Nokia N95 smartphones, wireless Bluetooth folding keyboards, and a 1GB per month 3G data account. By mid-semester student and lecturer feedback on the mLearning project was so enthusiastic that first and second year lecturers requested the researcher to establish similar mLearning projects with their students. Thus in semester two of 2008 the researcher facilitated mLearning project COPs with eight volunteering students and their lecturer in the first year of the course (using Apple iPhone 3Gs) and with eight volunteering students and their lecturer in the second year of the course (using Nokia N95 smartphones and Bluetooth folding keyboards).

During 2008 participating lecturers noted that the integration of mobile Web 2.0 within the course significantly engaged students and provided the basis for a flexible, context-bridging learning environment. On that basis the Product Design lecturers, along with the help of the researcher (as the technology steward; Wenger et al., 2009; Wenger et al., 2005), planned the integration of mobile Web 2.0 tools across all three years of the course for all Product Design students and lecturers in 2009. While it was believed that a student-owned smartphone model was the best ultimate approach, it was decided to further the seeding of mobile Web 2.0 into the programme by providing students with institutionally loaned smartphones.

Focus group feedback from participating students in 2008 indicated that the coverage of mobile Web 2.0 affordances during the 2008 COPs was too broad, presenting a high cognitive load for the students. Students were overwhelmed by the options available in the timeframe provided, and would have preferred to have focused on fewer affordances, and to have used them well. Therefore specific mobile affordances were chosen and utilized as a focus in the 2009 Product Design course (See Table 1, the tinyurls reference Educause “7 things” series of articles on each technology). Students’ core activity was situated around a reflective blog (http://www.vox.com) that was accessible via mobile devices, and provided a key source of participant reflections. Students’ Vox blogs were planned to become reflective journals of their design processes and learning throughout the year, as well as building up a showcase (eportfolio) of their product design capabilities. In particular the use of Vox blogs was expected to increase students abilities to

- become critical reflective thinkers as well as creative designers;
- collaborate, communicate and convey ideas; and

- to work with new technologies as part of the process (mobile Web 2.0 being core in enabling this).

Table 1. Affordances of smartphones mapped to social constructivist activities

Activity	Overview	Examples	Pedagogy
Video Streaming	Record and share live events.	Flixwagon, Qik http://www.qik.com	Real-time event, data and resource capturing and collaboration.
Geo tagging	Geotag original photos, geolocate events on Google Maps.	Flickr, Twitter, Google Maps http://tinyurl.com/5a85yh	Enable rich data sharing.
Micro-blogging	Post short updates and collaborate using micro-blogging services.	Twitter http://tinyurl.com/2j5sz3	Asynchronous communication, collaboration and support.
Txt notifications	Course notices and support.	Txttools plug-in for Moodle and Blackboard	Scaffolding, learning and administrative support.
Direct screen sharing	Video out to video projector, or large screen TV.	Microvision Show http://tinyurl.com/celgot	Student presentations, peer and lecturer critique.
Social networking	Collaborate in groups using social networking tools.	Vox groups, Ning, peer and lecturer comments on blog and media posts http://tinyurl.com/4uz6rj	Formative peer and lecturer feedback.

In order to achieve an explicit move to a social constructivist learning environment using mobile Web 2.0 tools in 2009, a staged and scaffolded approach was adopted. The 2009 project implementation was influenced by reflections upon the 2007 and 2008 mLearning projects, and also the recent conceptualizations of mLearning around the emergence of new learning theories based broadly upon social constructivist foundations. These included Authentic Learning (J. Herrington, Mantei, Herrington, Olney, & Ferry, 2008), Pedagogy 2.0 (McLoughlin & Lee, 2008a), Learner Generated Contexts and the Pedagogy, Andragogy, Heutagogy (PAH) continuum (Luckin et al., 2008). Luckin et al. (2008, 2010) propose the concept of Learner Generated Contexts (LGC) as a potential framework for technology-based learning founded on the Vygotskian concept of "Obuchenie" that encompasses both teaching and learning. Though not explicitly limited to mobile learning, the concept focuses upon learning

within learners' own environments that new technologies facilitate. "Obuchenie" blurs the distinction between teaching and learning, creating a two-way dyadic interaction within the Zone of Peripheral Development (Vygotsky, 1978). Luckin et al. (2008, 2010) propose a reconceptualization of the level of influence the teacher plays in these contexts, and attempt to break down the boundaries between learning and teaching implied in the PAH continuum (Pedagogy–Andragogy–Heutagogy) (see Table 2). The concept of LGC breaks down the separation of pedagogies by educational sector shown in Table 2, proposing that heutagogy need not be the domain of doctoral research only.

Table 2. The PAH continuum

	Pedagogy	**Andragogy**	**Heutagogy**
Locus of control	Teacher	Learner	Learner
Educational sector	Schools	Adult education	Doctoral research
Cognition level	Cognitive	Metacognitive	Epistemic
Knowledge production context	Subject understanding	Process negotiation	Context shaping

Luckin et al. (2008, p. 10).

Reflecting on the PAH continuum, the integration of mLearning (mobile Web 2.0) across the three years of the Bachelor of Product Design programme in 2009 was structured as follows in Table 3, creating a progression from pedagogy (lecturer-directed) in first year, facilitated by the introduction of Web 2.0, to heutagogy (student-directed) in the third year, facilitated by the unique affordances of mobile Web 2.0 to create student-generated contexts. The planned staged approach for the 2009 mLearning integration project therefore allowed the bridging of the PAH continuum (Table 2), and the embedding of mobile Web 2.0 affordances that support each stage.

Table 3. Scaffolding the rollout of mobile Web 2.0 throughout the Product Design course

Implementation stage	Web 2.0 tools	mLearning tools	Course timeframe and focus	PAH alignment
Level 1	Social collaboration with peers and lecturer.	Introduction of netbooks and establishment of basic Web 2.0 sites.	Semester1, Year1 Blogging.	Pedagogy
Level 2	Student-generated content.	Netbook plus mid-range smartphone (Nokia XM5800).	Semester2, Year1 Student Vodcasts, geotagging, moblogging.	From Pedagogy to Andragogy
Level 3	Social collaboration with peers and external "clients". Context aware	Student-owned laptop plus mid-range smartphone (Nokia XM5800).	Year2 Social networking, Mobile Codes, Geolocation.	Andragogy
Level 4	Context independent. Student-generated contexts.	Student-owned laptop plus high-end smartphone (Nokia N97).	Year3 Microblogging, facilitation of "virtual studio", location recording.	From Andragogy to Heutagogy

Bachelor of Product Design 2009 mLearning Projects

All students and lecturers across the three years of the Bachelor of Product Design course were included in the 2009 mLearning project (15 first year students and their lecturer, 15 second year students and their lecturer, and 24 third year students and their lecturer), allowing full integration into the course delivery and assessments and facilitating staging of the cognitive and technological learning required to integrate these tools, beginning with the establishment of the basics of Web 2.0 appropriation in first year to leveraging WMDs to enable student-generated learning contexts in third year.

First Year Mobile Project: Establishing student ePortfolios (Pedagogy)

The first year project was designed to lay a foundation for the mobile Web 2.0 projects to build upon in the second and third year of the course. The pedagogical focus was thus more teacher directed (pedagogy). The first year project integrated blogging, followed by moblogging (mobile blogging) into the course, scaffolding the introduction of Web 2.0 and mobile Web 2.0 tools into the students' learning experience to facilitate the beginnings of their online eportfolio and introduction to the educational use of social networking for collaboration. The core assessment involved an online blog/eportfolio documenting and showcasing students' design processes and forming the basis of the beginnings of a collaborative hub with their class peers. Students were supplied with a Dell mini9 3G netbook in semester one, and this was supplemented with the addition of a Nokia Xpressmusic 5800 smartphone (XM5800) at the end of semester one.

Second Year Mobile Project: Exploring mobile affordances (Andragogy)

The focus of the second year project was on a move from pedagogy to andragogy, building on the students' first year mobile Web 2.0 experience, integrating moblogging, social networking and student-generated content into the course, facilitating more in-depth collaboration and peer critique. The majority of these students had established an online eportfolio in the previous 2008 mLearning project. The 2009 project utilized the Nokia Xpressmusic 5800 to facilitate an assessed online blog/eportfolio documenting and showcasing students' design processes, forming the basis of collaborative critique and showcasing with worldwide peers and potential employers or clients. Ning was used as a teacher-facilitated collaborative hub for all the projects. Second semester projects focused on sharing and critiquing projects using Google Docs and Vox Group blogs, using the smartphone to capture and share project progress and presentations.

Third Year Mobile Project: Facilitating student generated contexts (Heutagogy)

The third year mLearning project focused upon the unique affordances of mobile Web 2.0 to create context-bridging learning environments that facilitated a move from Andragogy to student-generated projects and student-generated contexts (Heutagogy). Students and lecturers were supplied with Nokia N95 smartphones and upgraded to the Nokia N97 in semester two. The third year course is based around a studio design model where students undertake three design projects throughout the year, one of which is substantial and developed by the students themselves, with the guidance of their lecturers. The project involved documenting the research and design of these products throughout the year, including working with a client company in small design teams. The first project was a collaborative project with Applied Trades and Landscape Design students. The mobile Web 2.0 technologies were also used to establish a weekly virtual "nomadic" studio session that was not limited by a physical design studio space, with staff and students focusing on context bridging and full integration of moblogging into course projects, allowing students to visit design and production companies and work on their projects anywhere during this time. Students were required to maintain an online blog/eportfolio documenting and showcasing their design processes and forming the basis of a collaborative hub with worldwide peers and potential employers/clients. Additionally, communication and collaboration made use of instant messaging,

microblogging, and reflective VODCasts during the "nomadic" (beyond the classroom) studio session.

Discussion

A comparative analysis of student activity and feedback across the three year-groups of the course provides a basis for critiquing the success of the staged implementation of mLearning integration into the course in 2009. A comparison of the three mobile usage surveys indicates significant average smartphone use differences between the three years of the course. The first year project's main focus was upon developing students' use and integration of Web 2.0 tools (facilitated by the netbook and the smartphone), rather than upon the unique affordances of the smartphone, this being the focus of the second and third year projects. Thus while the first year students experimented with the unique multimedia affordances of the smartphones, they did not (in general) as a group socialise the everyday use of these unique affordances into their course. The use of the unique affordances of the smartphones was encouraged, but was optional in their projects. The structured nature of the first year projects followed a more teacher-directed pedagogical learning environment than the second and third years.

The second year students, in general, socially rejected the unique affordances of the XM5800 smartphone and tended to revert to standard use of the phone, with the exception of image and video blogging that were used for facilitating student-generated content. This was because many of the second year students found the XM5800 too complicated for these general activities. While the unique affordances of the smartphone were introduced by the technology steward (researcher), they were not modelled by the second year lecturer within authentic contexts, and therefore students struggled to conceptualise the use of these affordances within their course. Most of the second year students expressed their engagement with the mLearning project, but rejected the XM5800 as a device. Their feedback indicated that they preferred the previous 2008 mLearning project use of the iPhone 3G when they were first year students. "The Nokia's UI was so bad and non-intuitive that I didn't use the phone as much as I wanted—I really like the whole idea—just not this phone" (example second year student feedback). Interestingly many of the students in the other second semester mLearning projects (Architecture and Performing and Screen Arts) expressed deep personal appropriation of the XM5800, with most reluctantly returning the device at the end of their 2009 projects. The social non-appropriation of the XM5800 by one or two vocal students appears to have been very influential in the second year Product Design project. This illustrates the influence of the social construction of technology (Bijker, 1995) on technology appropriation.

In contrast, the third year students appropriated the multimedia and communications capabilities of the N95 and N97, using a wide range of mobile Web 2.0 affordances including instant messaging, Twitter, and QR Codes. The GPS and maps integration of the smartphones was also highly rated by the students, but used most frequently by third year students. The third year students maximized the use of the unique affordances of the smartphones within authentic contexts provided by their unstructured final-year design projects, which followed the development of a heutagogical learning environment modelled by the course lecturer (Cook, Bradley, Lance, Smith, & Haynes, 2007; Cook, Pachler, & Bradley, 2008; Luckin et al., 2008). The third year lecturer reflected

> The standard Atelier Method or studio teaching environment of one communal space and one timetable is unlikely to offer the best support and learning opportunities for today's creative students; it does not mirror the "real contemporary world". Over the last two to three years, the introduction of mobile Web 2.0 tools into the Bachelor of Product Design has facilitated significant flexibility for students, allowing them to stay connected, share their ideas widely, participate in worldwide creative communities and choose to work in virtually any context on and off campus. (Course lecturer, 2009)

The mLearning integration within the course was scaffolded by the use of an intentional community of practice (COP) model (Langelier, 2005) comprising weekly support sessions involving the course lecturers, the researcher (as the technology steward) and the course students. The face-to-face weekly mLearning COP support sessions were highly valued by the first and third year students and lecturers, forming the basis of a significant learning community around the mLearning projects. However, unlike the first and third year projects, the second year lecturer did not place as much value on the weekly COP sessions, often postponing them, double-booking with guest lecturer sessions, or simply forgetting about them, and did not regularly attend the COPs himself, leading to weak learning community formation around the mLearning project in the second year.

Student Feedback

The final student surveys and focus group questions provided further data on student feedback on the three 2009 Product Design mLearning projects. Table 4 below summarises and compares student feedback in the form of collated answers to the final student survey questions.

The feedback from the third year students was overwhelmingly positive, indicating that the mLearning integration into their course was perceived as very beneficial in almost all areas. The majority of first year students enjoyed the mobile Web 2.0 projects, with none finding it a disagreeable experience. Though largely negative about the smartphone used in the project, 73% of the second year students were interested in further educational smartphone use. What Table 4 does not convey is that with several of the first and second year student survey responses there was a significant percentage of "uncertain" responses, but very few "disagree" and almost no "strongly disagree" responses. Most first and second year students appropriated the personal use of the smartphones but did not use their unique affordances to enhance group collaboration and communication, particularly with lecturers who had not supplied their phone numbers or utilized instant messaging or Twitter to facilitate communication with their students. This was the factor that influenced students' "uncertain" responses—they could see the value of the mobile Web 2.0 integration, but did not see it in practice from certain lecturers. This was confirmed by the focus group feedback. Very little formative feedback was posted as comments to students' blogs by the second year lecturers. In contrast the first and third year lecturers actively participated on the student blogs. Additionally, several of the third year students utilized instant messaging and Twitter on their smartphones to stay in constant communication and collaboration with their lecturer, the researcher, and their student peers, facilitating a context-bridging learning community that the second year students did not experience.

Table 4. Comparative Product Design Student Survey Feedback 2009

End of project survey question	Percentage student agreement/satisfaction with statement (strongly agree plus agree)		
	Year1 (n=15)	Year2 (n=15)	Year3 (n=24)
4. What has been your experience of group work facilitated by Blogs and RSS?	60%	57%	80%
6. It was easy to use the smartphone?	20%	64%	100%
7. This mobile learning experience was fun.	70%	55%	100%
8. Based on my experience during this trial, I would use a smartphone in other courses	50%	73%	100%
9. I would be willing to purchase my own smartphone?	40%	73%	100%
11. In your opinion, does mobile learning increase the quality of learning?	80%	73%	100%
12. Mobile blogging helped create a sense of community (group work)?	60%	82%	80%
13. Accessing your course blog was easy using the mobile device?	40%	46%	100%
14. Mobile learning increases access to education?	50%	64%	100%
15. Communication and feedback from the course tutor/lecturer were made easier?	70%	55%	80%
16. Mobile learning is convenient for communication with other students?	90%	82%	80%

Case Study Analysis

This section brings out some of the key themes highlighted by the mLearning integration into the Bachelor of Product Design programme in 2009. Lecturer and student feedback on the project is available on YouTube:

- Lecturer feedback: http://www.youtube.com/watch?v=mmTI7F_2tiU
- Student feedback: http://www.youtube.com/watch?v=X1Sb-tvXrvA

Implications for the Research Questions

In general the integration of mobile Web 2.0 technologies into the Bachelor of Product Design has been very successful. As the case studies show, the student and lecturer experience within the programme have been enhanced through the facilitation of a social constructivist environment that bridges multiple contexts. Over the last three years significant changes in pedagogical approach and levels of student engagement have been realised. The future aim is to continue to build upon the insights gained, focusing upon the PAH alignment of the unique affordances of mobile Web 2.0 (Table 1), using a staged and scaffolded model (Table 3) to fully embed mobile Web 2.0 tools into the entire Bachelor of Product Design curriculum. Additionally, the importance of both technical and pedagogical scaffolding for both the lecturers and students via a community of practice model has been found to be critical.

While the research has sought to produce transferable principles and strategies to enhance tertiary education using mobile Web 2.0, it is ultimately bound by the limits of the contexts of the learning communities that it is embedded in, and the current affordances of the available mobile Web 2.0 technologies. To create a sustainable approach, the goal going forward is to move to a student-owned model, where students purchase their own smartphone. It is yet to be seen whether there can be transferability of the research outcomes based upon an institution supplied or specified WMD and mLearning projects based upon student-chosen and owned WMDs (Traxler, 2010).

What are the key factors in integrating Wireless Mobile Devices (WMDs) within tertiary education courses?

While every implementation of mLearning and each learning context will be unique, several key factors have been identified by the research that have proven to be important across multiple mLearning implementations and contexts (Cochrane, 2010). The pedagogical integration of the technology into the course criteria and assessment is critical. Lecturer engagement and modelling of the pedagogical use of the WMDs is essential. These changes in curriculum design and practice (and student acceptance) take time (Chi & Hausmann, 2003); in the example case study given this time frame has spanned several years. Innovative practice must take a scaffolded and staged approach to implementation, and lecturers (and students) require significant pedagogical and technical support during this time.

What challenges/advantages to established pedagogies do these disruptive technologies present?

Mobile Web 2.0 tools are "disruptive" technologies (Sharples, 2001) that democratize the learning environment, empowering students, and providing opportunities for social constructivist pedagogies. The ubiquitous connectivity of WMDs combined with the student content creation and sharing capabilities of Web 2.0 shift the learning focus from teacher-directed to student-centred learning (Bruns, 2007; Cochrane, Bateman, & Flitta, 2009; Laurillard, 2007). This learning can then occur across almost any context, bridged by the ability of the WMDs to augment, capture, share and communicate learning experiences (Cochrane, 2009; Vavoula, 2007b). This changes the role of the educator and the nature of learning for the students. For many lecturers integrating a social constructivist learning environment will mean redesigning assessments and

developing a new pedagogical "toolkit". This takes time and commitment. Technological and pedagogical support for these paradigm shifts is critical. These disruptions facilitate appropriate shifts along the pedagogy to heutagogy continuum (Cochrane, Flitta, & Bateman, 2009; Luckin et al., 2008; McLoughlin & Lee, 2008b).

To what extent can these WMDs be utilized to support learner interactivity, collaboration, communication, reflection and interest, and thus provide pedagogically rich learning environments that engage and motivate the learner?

Mobile Web 2.0 can be used to facilitate collaborative, authentic learning within authentic contexts (A. Herrington & Herrington, 2007; A. Herrington, Herrington, & Mantei, 2009). The aggregation of a variety of mobile Web 2.0 tools facilitates metacognition and reflection. Students demonstrate increased motivation and engagement when using personal devices and personalised media-rich learning spaces (JISC, 2009a, 2009b). Students initially engaged by the use of personal and innovative technologies can appropriate the pedagogical use of these tools when scaffolded and supported by learning communities guided by an appropriate technology steward (Cochrane, 2007; Wenger et al., 2009; Wenger et al., 2005).

To what extent can WMDs be used to harness the potential of current and emerging social constructivist e-learning tools?

Since the researcher's first attempts at marrying the affordances of Web 2.0 and mobile technologies in 2006, mobile Web 2.0 has developed into a range of viable, user-friendly, rich-media, flexible and context independent tools (Cook et al., 2007) that can be used to bridge both the formal and informal learning environments (Vavoula, 2007b), spanning both distance and time. As these tools develop further, so will their educational potential and richness.

Conclusions

The Product Design mLearning projects achieved demonstrable progress in course integration, pedagogical reconceptualisation, and development of a staged and scaffolded implementation model for developing learning communities facilitated by intentional communities of practice across each year of the course (Cochrane & Bateman, 2010). The community of practice established in the third year of the course during 2008 effectively drew in the other lecturers within the department who were brought into the project from the "periphery" of the COP. This aligns with Lave and Wenger's (1991) concept of "legitimate peripheral participation". This led to the use of mobile Web 2.0 tools and supporting COPs being integrated across the entire Bachelor of Product Design course in 2009. The case study illustrated the potential to stage and scaffold mLearning integration across all three years of a Bachelor's level course, based upon establishing an intentional community of practice involving both the students and the lecturers in each year supporting the mLearning projects. The progression of moving teaching from pedagogy to heutagogy (referred to as the PAH continuum by Luckin et al., 2008) was mapped with the progression of mobile Web 2.0 course integration from student Web 2.0 appropriation in first year (pedagogy) to student mobile-facilitated content creation (andragogy), as characterised by Bruns (2007) and JISC (2009a), in second year, and finally learner-generated contexts (heutagogy)

leveraging the context-bridging affordances of mLearning (similar to the recommendations of Luckin et al., 2010, and Vavoula, 2007a) leveraged in the third year "nomadic studio".

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