CHAPTER 13

Design principles for mobile learning

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Abstract:
*The **New technologies, new pedagogies** project used a design-based research approach in the creation and evaluation of pedagogies and their use in a range of higher education classes. This chapter describes the findings of the project as a whole, and presents principles to inform the design of innovative learning environments employing mobile technologies in higher education learning environments.*

Introduction

The *New technologies, new pedagogies: Using mobile technologies to develop new ways of teaching and learning* project used a design-based research approach to frame the design, implementation and evaluation of individual pedagogies for the use of mobile devices in higher education classes.

Teachers in semester courses in a Faculty of Education created pedagogies appropriate to their subject areas, using the affordances of mobile devices (iPod mp3 players and Palm Treo smartphones). Each innovative m-learning activity was designed, implemented, assessed and evaluated over 4-7 weeks of the semester unit. The findings of the evaluations enabled the analysis of 'lessons learned' to inform design principles for the use of mobile technologies in higher education classes.

From the outset, the project aimed to conclude with the production of guidelines or principles for the use of mobile technologies in higher education—a natural and logical outcome from a design-based research approach. This chapter describes the project findings and presents principles to inform the design of innovative learning environments employing mobile technologies in higher education learning environments. These principles can be used as practical guidelines or heuristics for the design of learning tasks using mobile technologies. Such design principles are an important outcome of design-based research studies.

Design-based research

Design-based research has its focus on real world problems, and the overall goal of improving learning, rather than proving that one pedagogical approach is more effective than another.

In the first phase of design-based research, a problem is analysed in depth in consultation with the practitioners or teachers involved. A solution is then designed according to theoretical principles and with knowledge of recent technological affordances. The proposed solution (or *intervention* as it is sometimes known) is then implemented in two or more iterations, with adjustments and improvements made between

implementations, so that the emphasis remains on finding the best way to present the subject in the particular pedagogical context. The last phase is the creation of design principles based on the knowledge gained from the theory, practice and reflection of the previous phases. The focus of the approach is always upon *improving* the learning design, rather than *proving* that one approach works better than another.

One of the most powerful aspects of using design-based research is its emphasis on sharing and disseminating findings and principles (Wang & Hannafin, 2005). The value of design principles lies in the contribution they make to the professional community.

The output of any research framed in the form of principles, ensures that, firstly, the findings of the research are presented in a form that is readily adaptable to other contexts, and secondly, that the knowledge created is not lost to the professions (Herrington, McKenney, Reeves & Oliver, 2007; Reeves, 2006).

Design principles both emerge from, and connect to, theories of learning and instruction (Design principles database, n.d.). They advance both practical and theoretical understanding of the focus area, and as noted by Barab and Squire (2004) must move beyond local conditions to contribute to theory:

> Design-based research requires more than simply showing a particular design works but demands that the researcher (move beyond a particular design exemplar to) generate evidence-based claims about learning that address contemporary theoretical issues and further the theoretical knowledge of the field. (pp. 5-6)

What are design principles?

In a practical sense, design principles can refer to characteristics of a planned learning design (what it should look like), or its procedure (how it should be developed) (van den Akker, 1999). Above all they must be expressed in a way that can inform practice (Wang & Hannafin, 2005).

Design principles are best expressed in active terms that enable their ready use by teachers and designers presented with similar contexts and problems. Van den Akker advised that design principles usually take the form of heuristic statements such as:

> If you want to design intervention X [for the purpose/function Y in context Z], then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of arguments P, Q, and R. (p. 5)

Design principles are often presented in a form that lists criteria of particular learning environments and outcomes, and when presented this way, often start with a verb. For example, Jonassen (1994) proposed that knowledge construction may best be facilitated by constructivist learning environments that:

- provide multiple representations of reality, which avoid oversimplification
- focus on knowledge construction, not reproduction
- present authentic tasks (contextualising rather than abstract instruction)
- provide real world, case based learning environments rather than pre-determined instructional sequences
- foster reflective practice
- enable context- and content-dependent knowledge construction
- support collaborative construction of knowledge through social negotiation, not competition (p. 35).

In another example, Boud and Knights (1996) proposed that the following principles are important in introducing and establishing a productive educational climate for reflection:

- articulating an educational rationale for the process
- introducing a simple exercise to illustrate reflection
- providing an opportunity for students to clarify their understanding of the idea
- introducing a framework or model to aid thinking about elements of reflection
- modelling a reflective approach in one's own presentation of the idea
- identifying areas of the process that students can make their own
- providing time
- treating reflection as a normal activity (p. 30).

Such design principles are not fixed, and are offered as advice on how others might benefit from the findings of a particular development and research endeavour. As noted by Reeves (2000): 'Instructional technologists engaged in [design-based] research are above all reflective and humble, cognizant that their designs and conclusions are tentative in even the best of situations' (p. 11).

Findings from the *New technologies, new pedagogies* project

The 'tentative' conclusions and principles from the overall m-learning project have been derived from a review of each of the individual projects, and a summary of both their substantive and procedural emphases.

To assist in establishing the design principles, Table 1 below provides a summary of the purpose of each of the projects presented in the chapters of this book, together with a list of the *characteristics* of each pedagogy (the substantive emphasis) and the *method* that was employed in instantiating the pedagogy into classroom activities (the procedural emphasis). The method section has been further refined to indicate the roles of *teacher* and *learners* as implemented and observed in each learning environment.

Table 1: Summary of substantive and procedural elements of projects

Purpose of mobile pedagogy	Substantive emphasis CHARACTERISTICS	Procedural emphasis METHOD
Adult educators used smartphones to create a digital story for use as a teaching resource (described in CHAPTER 3: Herrington, A.)	• Real world relevance • Integration of technology • Blended technologies • Collaboration • Sharing of outcomes • Owning the technology • Opportunistic data gathering	The teacher: • Introduces an authentic workplace task • Provides initial instruction and demonstration The students: • Familiarise themselves with the devices • Plan the task • Capture media that exploits the affordances of the technology • Create a digital story using computer based software • Produce a curriculum resource • Give collaborative feedback • Share with others via a social networking site
Preservice teachers in groups created digital story books for young children, using sound and images to author stories with elements that appeal to very young children. Students created their stories using PowerPoint and then published them to iPods as podcasts (described in CHAPTER 4: Olney, I., Herrington, J., & Verenikina, I.)	• Real world relevance • IT as a cognitive tool • Blended technologies • Collaboration • Reflection • Sharing of outcomes • Opportunistic data gathering	The teacher: • Sets an authentic language and literacy task • Models IT content and pedagogical knowledge The students: • Plan and write the story • Capture audio using an iPod • Create a digital story using computer based software • Share with others via a presentation and podcast • Reflect on the process in an electronic journal
Using the features of mobile phones, third year preservice primary teachers prepared, implemented and evaluated a unit of work that supported the waste, water and energy management programs of classes in five host schools. (described in CHAPTER 5: Ferry, B.)	• Real world relevance • Professional development • Blended technologies • Collaboration • Sharing of outcomes • Ownership of technology	The teacher: • Introduces an authentic environmental education task • Enables familiarisation with phone through peer discussion and teacher instruction • Establishes action learning sets The students: • Prepare, implement and evaluate a unit of work about waste, water and energy management for a class of year five or six students • Record, share and reflect on teaching events individually and with peers • Blend mobile technology with PowerPoint • Produce a curriculum resource
Using a constructivist perspective, postgraduate students designed a resource for teachers/trainers that exploits the affordances of mobile technologies (described in CHAPTER 6: Herrington, A.)	• Real world relevance • Modelling of processes • Constructivist learning theory • Educational affordances of mobile technologies • Technology integrated curriculum	The teacher: • Introduces an authentic curriculum development task • Demonstrates an appropriate activity using a mobile device The students: • Create a learning resource based on constructivist principles • Choose the most appropriate technology for the task
iPods were used to create audio files of professional dialogue captured during workshops and uploading them to a repository for teachers to access as needed. (described in CHAPTER 7: Mantei J., & Kervin, L.)	• Mobile context • Knowledge management • Blended technologies • Professional development • Collaboration • Reflection • Sharing of outcomes	The teacher: • Introduces an authentic professional development activity • Demonstrates and scaffolds the task The students: • Capture audio using an mp3 player • Analyse professional knowledge • Use computer based software for collation, editing and uploading of completed files • Share professional knowledge via a website

Purpose of mobile pedagogy	Substantive emphasis CHARACTERISTICS	Procedural emphasis METHOD
Second year primary preservice teachers investigated the use of Smart phones to facilitate interactions and reflections about K-6 mathematics concepts and the teaching of these concepts in the classroom (described in CHAPTER 8: Chinnappan, M.)	• Professional development • Collaboration • Reflection • Modelling of processes	The teacher: • Introduces an authentic curriculum development task The students: • Discuss and negotiate a focus topic, resources and activities • Capture images and video for teaching purposes using a mobile phone • Share and reflect on content and pedagogical content knowledge • Modify understandings emerging from reflection and discussion
iPods were used by pre service physical education and health teachers to enhance their understanding of questioning methods, the development of dialogue and the pedagogical use of Game Centred Approaches in physical education lessons. (described in CHAPTER 9: Forrest, G.)	• Mobile context • Game centred approaches (GCA) • Blended technologies • Professional development • Collaboration • Reflection	The teacher: • Introduced GCA and the method of capturing audio data for reflection The students: • Plan a lesson using GCA with a focus on questioning from developing understanding • Record dialogue during the lesson and the ensuing discussion about the effectiveness of questioning techniques • Create a personal reflection • Use computer-based software to store files and create permanent records of the lessons
Fourth year primary preservice teachers used iPods to create a collective of wisdom stories from experienced teachers that was made available to their peers as podcasts (described in CHAPTER 10 : Kervin, L., & Mantei, J.	• Mobile context • Professional development • Knowledge management • Exploring aspects of the profession • Reflection • Blended technologies • Sharing of outcomes • Opportunistic data gathering	The teacher: • Provides initial input and literature The students: • Identify and research the topic • Plan the interview questions • Capture interviews using an ipod • Create teacher wisdom stories using computer based software • Share professional dialogues via a weblog
Students used the multimedia capabilities of the smartphone to create slowmation videos for primary aged children in order to develop understanding of scientific concepts. (described in CHAPTER 11: Hoban, G.)	• Mobile context • Constructionist • Professional development • Blended technologies • Collaboration	The teacher: • Science content and pedagogy The student: • Plan the task • Capture video using a mobile phone • Create a slowmation • Use computer-based software to combine audio and video data into a movie file • Share with others via a presentation
Fourth year primary preservice teachers used a public art gallery as a resource for interactive visual arts learning experiences. The students created presentations on their findings that were presented and submitted on the iPods as podcasts (described in CHAPTER 12 : Brown, I.)	• Real world relevance • Mobile context • Collaboration	The teacher: • Introduces an authentic site based task The students: • Plan a learning activity utilising community and environmental resources • Create content for mobile device • Develop and construct an iMovie/ podcast/ videocast • Produce supporting documentation • Produce a curriculum resource • Peer assess

Despite each activity having a unique purpose in relation to its curriculum area and task, a number of similar elements and patterns emerge from this analysis. These elements are synthesised below in the form of *design principles*.

Design principles for mobile learning

From analysis of the data, the following characteristics are recommended for the incorporation of mobile learning into a higher education learning environment:

1. Real world relevance: Use mobile learning in authentic contexts
2. Mobile contexts: Use mobile learning in contexts where learners are mobile
3. Explore: Provide time for exploration of mobile technologies
4. Blended: Blend mobile and non mobile technologies
5. Whenever: Use mobile learning spontaneously
6. Wherever: Use mobile learning in non traditional learning spaces
7. Whomsoever: Use mobile learning both individually and collaboratively
8. Affordances: Exploit the affordances of mobile technologies
9. Personalise: Employ the learners' own mobile devices
10. Mediation: Use mobile learning to mediate knowledge construction.
11. Prod*use*: Use mobile learning to produce and consume knowledge.

Each of these principles is described in more detail below:

Real world relevance: Use mobile learning in authentic contexts

Mobile learning occurs in authentic contexts. Problems, challenges, investigations, and explorations that mobile learners engage with are situated in real world contexts that have personal meaning and relevance, allowing deeper understandings to be achieved. The contexts may be commercial, educational or purely lifestyle, and will often involve characteristics of collaboration, reflection, and articulation, (Herrington & Herrington, 2006). For example, adult learners studying in (Herrington, Chapter 3) made real connections to their workplaces as they created instructional 'how to' videos for their colleagues.

Mobile contexts: Use mobile learning in contexts where learners are mobile

Mobile technologies such as mobile phones, smartphones, personal digital assistants and mP3 players support learners on the move, whereas technologies such as laptops, digital cameras, desktop computers do not (Traxler, 2007). Sharples, Taylor and Vavoula (2007) contend that mobile learning is situated in contexts where the learner is mobile across topics, space and time. Commuters engage in mobile learning as they travel to and from work accessing different information and engaging in different tasks, returning to these tasks at different times throughout the day. Clear evidence of mobile learning in this project is seen where early career teachers created audio files of teacher wisdom stories (Kervin & Mantei, Chapter 10) for use as a tool for reflection on teaching.

Explore: Provide time for exploration of mobile technologies

While it is apparent that many higher education students have a greater familiarity with technology than their predecessors it is also clear that some do not. Providing time for students to explore the technological features and educational affordances of devices can be done in a variety of ways. Sharing knowledge, peer tutoring and engaging in introductory authentic tasks appear to be useful approaches to developing in students the important understandings of how and when to use the available tools on offer. Evidence indicating the benefits of providing time for students to 'play' with the technologies is provided in Chapter 6 (Herrington)

Blended: Blend mobile and non mobile technologies

Mobile learning can be enabled by technological tools and infrastructure. Mobile technologies are portable, personalised, and increasingly convergent. People always have them on hand and populate them with personal profiles and playlists, performing a multiplicity of functions. Wireless and telephone networks provide the infrastructure for mobile learners to access and remain networked and connected. There are learning tasks that benefit from a blending of mobile and non mobile devices. The capacity to sync information and download media adds to the versatility of these devices. For the cases in this project, the blending of mobile and non-mobile technologies enriched the final outcome of the learning task, for example, in creating electronic books for young children discussed in Chapter 4 (Olney, et al.), where preservice early childhood teachers used a combination of mobile technologies and computer software to develop, publish and share their texts.

Whenever: Use mobile learning spontaneously

Mobile learning can be spontaneous, unanticipated and opportunistic. Being in the right place at the right time to capture significant events provides invaluable knowledge for individuals as well as communities, witnessed by the current reliance of news services on opportunistic recordings made by mobile learners and their technologies. Preservice teachers in this project were able to capitalise on the spontaneous events occurring in their classrooms in order to capture perspectives of pedagogical approaches for later exploration, for example, when learning about game centred approaches to teaching in physical education, the iPod afforded opportunities for the preservice teachers to capture the dialogue as it occurred spontaneously in the lesson (Forrest, Chapter 9).

Wherever: Use mobile learning in non traditional learning spaces

Mobile learning can occur wherever people find a need. Traditionally learning is seen to occur in formal settings like classrooms and lecture theatres whereas informal learning occurs as we wait for a bus, converse with a colleague over lunch, or engage in work experience. Research by Vavoula indicates a surprising diversity of contexts in which learning is located (Vavoula, 2005). Products created in the art gallery by preservice teachers (Brown, chapter) take learning about art and architecture beyond the classroom and into the location where it resides. The ubiquity of mobile devices and the widespread coverage

of wireless and telephone networks enables learning to occur independent of location.

Whomsoever: Use mobile learning both individually and collaboratively

Mobile learning can occur individually and collaboratively. Listening to a podcast can provide an individual with the knowledge he or she is seeking. Creating and sharing a podcast or audio file requires reflection on knowledge (as does any teaching) and an opportunity to work with others in the process. Using a focus on teaching within an environmental education subject (Ferry, Chapter 5) required the teachers to individually select and reflect on aspects of their teaching that were also relevant for peer discussion and collaboration as the pre service teachers identified areas for pedagogical change and growth.

Affordances: Exploit the affordances of mobile technologies

In some circumstances it is better to choose one technology over another. A digital camera for instance may provide higher resolution images than those taken with a mobile phone. However, being ubiquitous and portable, there is a greater chance that the mobile phone will enable the user to capture spontaneous events. While a number of teachers in this project (Hoban, Chapter 11; Ferry Chapter 5; and Herrington, Chapter 3) acknowledged the inferiority of the camera in the smartphone for capturing high quality images, they indicated portability and convenience as overriding factors because the camera produced images that were sufficient for the task.

Personalise: Employ the learners' own mobile devices

Using a learner's own device ensures that many of the features of the devices are well known and practiced, although some students may not have used or been aware of all features (Oliver & Goerke, 2007). Students using devices other than their own require time not only to familiarise themselves with the device, but more importantly to 'play around' with the technology and personalise it for their own use. For example, following teacher demonstration and time to explore the 'new' smartphone, preservice teachers creating slowmation movies to demonstrate science concepts (Hoban, Chapter 11) had the option to use the device provided by the University or their own, allowing them to make informed choices about the uses and functions available when capturing the relevant material for their movies.

Mediation: Use mobile learning to mediate knowledge construction.

In educational activities it is common for educators and learners to engage in processes such as recording, representation, sharing and reflection to support knowledge construction and co construction, as happened as mathematics preservice teachers negotiated the construction of a curriculum resource (Chinnappan, Chapter 8). Mobile learning provides many opportunities where these processes can be mediated using mobile technologies. As well as being motivating for students the use of mobile technologies blended with web based technologies can provide resources that aid knowledge construction that are reusable, sustainable and scalable to a wide group of students. For example, early career teachers engaged in professional dialogue, described a sense of obligation to ensure a high

quality product for this broader audience beyond their own small group (Mantei & Kervin, Chapter 7).

Prod*use*: Use mobile learning to produce and consume knowledge

The predominant use of mobile learning has involved people consuming knowledge by way of podcasts, e books and accessing web sites. However, the active construction and co construction of content through media capture and subsequent content creation will increase as students and teachers adopt less transmissive and more constructivist approaches to teaching and learning. The proliferation of educational web 2.0 applications such as wikis and blogs that rely on the construction of content to be shared with others is an expanding area that exemplifies this trend. In this project, for example, the adult learners in Herrington's digital narrative task (Chapter 3) were initially consumers as they explored the genre of a digital narrative, but became creators of knowledge as they gathered and manipulated content for the creation of their own narrative and shared these via social networking sites for the consumption of others.

Conclusion

As Litchfield, Dyson, Lawrence, and Zmijewska, (2007) observed:

> A body of knowledge of learning and teaching principles and strategies is urgently needed to inform teachers wishing to utilise innovative mobile technologies and also to inform the development of national policy and pedagogical approaches about emerging mobile devices. (p. 591)

This project has gone some way to achieving this goal. In establishing a set of design principles for mobile learning in higher education, based on the experiences of teachers and learners in a Faculty of Education, the authors are mindful that not all principles may be relevant or necessary in all tertiary learning contexts. Nevertheless, these principles can provide useful guidelines for teachers, instructional designers and educational developers as they plan and develop curriculum resources for learners in the 21st century.

However, while much has been learnt about the capabilities of the devices and appropriate designs for teaching and learning through this project, these 'first generation' studies may well be insufficient to prompt the widespread uptake of mobile learning in higher education institutions (Traxler, 2005). According to Traxler we are now at a point where we should be looking more strategically at the implementation of mobile learning in higher education on a broader scale arguing that 'mobile learning will require 'second-generation' pilots or large-scale trials across institutions and across subjects if its wider potential is to be realised.' The *Mobile Learning Network* (Attewell, 2008) project is one example where large-scale trials are currently being conducted across the Further Education sector in England. The project has established a community of practice website providing, technical and pedagogical support, resources, professional development, mentoring and support for research and evaluation for over 30 action research projects at individual sites. A similar large scale endeavour appears justified in higher education if the lessons learned from this project are to gain widespread adoption.

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