RUNNING HEAD: REFLECTIONS ON SUCCESS

Reflections on Success: A retrospective of the mLearn conference series 2002-2005

Laura Naismith & Dan Corlett

Centre for Learning, Innovation & Collaboration (CLIC)

University of Birmingham, UK

{L.Naismith, D.J.Corlett}@bham.ac.uk

RUNNING HEAD: REFLECTIONS ON SUCCESS

Abstract

mLearn is now in its fifth year. Although mobile learning has a much longer history, the inauguration of a conference for learning in the mobile age marked an important point in its development. This paper takes a retrospective look at the mLearn conferences from 2002 through to 2005; reflecting on our progress in order to facilitate the transition of mobile learning from a novel research concept into a viable means of providing meaningful learning opportunities "across generations and cultures". We hope that this paper will act as a mini-compendium or ready-reference for those embarking on mobile learning projects, a starting point for those entering the field and a reminder to those who have already contributed to its making.

RUNNING HEAD: REFLECTIONS ON SUCCESS

Introduction

Background to mLearn

Mobile learning as a concept has a long history. Alan Kay originally proposed the Dynabook system in the early 1970s. Building on educational theories of Piaget and Papert, the Dynabook was intended to be a personal, portable device through which children of all ages could express themselves (Kay, 1972). It is only in recent years, however, that mobile technology, in the form of mobile phones, handheld computers and high speed wide area communications, can truly enable learning on the move. HandLeR, originally proposed as a student project, was the first technological embodiment of a personal, mobile system to support lifelong learning (Sharples, 2000; Sharples, Corlett & Holme, 2002). This project went on to receive funding from British Telecom and Kodak and sparked the development of an active mobile learning community at the University of Birmingham in the UK.

At the same time, mobile learning was beginning to be recognised as a legitimate research field in its own right. The European Commission, through the Information Society Technologies' (IST) programme, put their support behind two large mobile learning projects – m-learning (www.m-learning.org) and MOBIlearn (www.mobilearn.org). The m-learning project, launched in October 2001, had participating institutions in the UK, Sweden and Italy. It was aimed at young adults, aged 16-24, who had left formal education and thus were at risk of social exclusion in Europe. The objectives of the project were to develop prototype products and services that would deliver information and learning experiences through a variety of mobile technologies. The MOBIlearn project, launched in July 2002, involved a consortium of 24 academic and industrial partners from Europe, Israel, the USA and Australia. Its aim was to

explore context-sensitive approaches to mobile learning for informal, problem-based and workplace learning.

In June 2002, the University of Birmingham hosted the first mLearn workshop (www.eee.bham.ac.uk/mlearn/). Termed the 'European Workshop on Mobile and Contextual Learning', it brought together researchers and practitioners from both industry and education. Whilst the 32 submissions indicated a range of research and development initiatives, the focus of the conference was mainly on UK-based projects.

Building a Community

The LSDA (LSDA), the coordinating partner of the m-learning project, organised and hosted mLearn 2003 (www.feda.ac.uk/events/mlearn2003/) in London, UK. The theme of this conference was "learning with mobile devices" and though the audience had expanded significantly as compared to the previous year, the submissions were still predominantly UK-based. mLearn 2004 (www.mobilearn.org/mlearn2004/) moved outside of the UK for the first time to Bracciano, Rome and was organised by the MOBIlearn project. The theme of this conference was "learning anytime, everywhere" and the number of papers submitted was more than double that of the previous year (56 compared to 27). The international nature of the mobile learning community was also beginning to emerge – submissions were received from 16 different countries, including Romania, Canada, the USA and South Africa.

Though the m-learning and MOBIlearn projects had officially concluded by 2005, by this time a substantial and diverse mobile learning community had been consolidated. When mLearn 2005 (www.mlearn.org.za) was hosted in Cape Town, it was the key research and networking event for researchers, strategists, educators, technologists and practitioners from around the

world. The theme of the conference was "Mobile technology: The future of learning in your hands", and submissions were received from 18 different countries, including for the first time Brazil, Colombia, Guatemala, Israel, Cyprus and the Netherlands. Importantly, 15 of the 59 submissions highlighted the important role that mobile learning was playing in Africa.

The true success of the mobile learning community can be seen in the number of events and conferences specifically focused around mobile learning. These include international conferences such as the IEEE's annual conference on Wireless and Mobile Technologies in Education (WMTE) and the annual IADIS Mobile Learning Conference, as well as several regional events. In Europe, the Kaleidoscope Network of Excellence is sponsoring a Mobile Learning Initiative (http://www.noe-kaleidoscope.org/group/mlearning/) and in the United States, EDUCAUSE is focused on exploring Mobility and Mobile Learning through a dedicated Learning Initiative (http://www.educause.edu/MobileLearning/5527).

Structure of this Paper

In this paper, we identify successful projects from the mLearn community and examine their positive outcomes. Next, we describe patterns we have identified, based on the common features shared by these projects, and corroborated by published results from the mLearn proceedings. These are then abstracted and distilled into set of critical success factors (CSFs) that can be used to inform both future developments and policy initiatives. Finally, we discuss the current challenges facing educators and technology developers in incorporating mobile learning into mainstream educational provision.

RUNNING HEAD: REFLECTIONS ON SUCCESS

Positive Outcomes of Successful Projects

In this section, we highlight six outcomes of successful projects from the mLearn community. Examples are drawn from a number of countries and learner profiles to demonstrate how mobile learning is truly reaching 'across generations and cultures'.

Motivation

There is evidence from across the mLearn community to suggest that mobile learning has a significant impact on learner motivation. According to Butler (2002), "site-wide wireless coverage has transformed" (p. 57) the teaching and learning at Djanogly City Technology College in Nottingham, UK. Students who previously found paper-based assessments to be tedious and nerve-wracking are now requesting extra time over breaks and lunchtimes to complete their assessments online. When mobile computing devices were introduced into classrooms in Ohio, USA, both students and teachers observed an increase in motivation, leading to increases in both the quantity and quality of student work (Swan, van `t Hooft, Kratkoski & Unger, 2005).

Mobile learning also enhances motivation outside the classroom. At the Tshwane University in Pretoria, de Crom and de Jager (2005) used PDAs during ecotourism field trips as an alternative to paper-based worksheets. They found that the use of the PDAs enhanced motivation by stimulating fun, curiosity, challenge, satisfaction and interest among their learners. In Oulu, Finland, Mattila and Fordell (2005) developed MOOP, an interactive mobile learning environment for primary school pupils. Learners use a variety of mobile phone features (camera, text messaging, GPS location tracking) to support them in cooperative, inquiry-led learning situations. Over 1000 pupils have used the system and have enjoyed both the opportunity to learn

by being immersed in their environment and the opportunity to learn how to use the various features of the mobile phones. In the students' own words, mobile learning is 'cool'.

Engagement

Closely related to motivation, mobile learning seems to promote high engagement in various learning activities. In Ohio, Swan et al. (2005) notes that students were particularly engaged when using mobile devices to record data from a variety of experiments. They propose that the portability and data storage capacity of the devices may have helped to alleviate the drudgery of working with data. A more exciting prospect noted by one of the students is that "mobile computing makes such activities seem more like what '*real scientists do*'" (p. 160). The EngageMe project from TAFE New South Wales, a member of the Australian Mobile Learning Network, engages young people in e-learning by providing opportunities for them to generate content and responses (Ragus et al., 2005). Camera and text features of the mobile phone are used, as these are technologies that the learner group readily embraces in their daily lives.

The portable nature of mobile devices also allows learners to engage with their environment. Naismith, Sharples and Ting (2005) evaluated the use of the CAERUS system to deliver location-based multimedia content to visitors in a botanic garden in Birmingham, UK. The participants in their trial showed increased engagement with their physical surroundings, as evidenced by being able to cite specific examples of things they had seen or heard, increased knowledge of the layout and organisation of the garden and a strong desire to explore further and receive more information. Bradley, Haynes and Boyle (2005) also use multimedia to engage users and "bring history alive" (p. 23) on a mobile local history tour in London, UK. All 10 of

their trial participants found the tour to be memorable and 9 of them reported it to be both stimulating and enjoyable.

Personalisation

Personalisation is about giving learners control over what, where, when and how they will learn. The effectiveness of mobile devices as learning tools stems from the personal nature of the devices themselves (Cereijo Roibás & Arnedillo Sánchez, 2002). By presenting information that is also perceived as personal, high levels of user attention can be captured.

There are several examples of mobile device applications designed around learner needs. The PDA-based Student Learning Organiser (Holme & Sharples, 2002; Sharples, Chan, Rudman & Bull, 2004) is designed around the needs of university students at the University of Birmingham, UK. It provides specialised support for time management and accessing course materials through the wireless network. Importantly, students on their trials were given full control over how they chose to use (or not use) the devices. Also from the University of Birmingham, the Interactive Logbook (Bull et al., 2005; Corlett, Chan, Ting, Sharples & Westmancott, 2005) is a personal learning environment (PLE) which helps users to plan, track, manage and review their learning activities. In contrast to institutionally provided learning environments, the Interactive Logbook allows uses to select a "personal suite of tools or resources according to individual learning styles and work habits" (Corlett et al., 2005, p. 32).

The design of learner-centred interfaces is not restricted to traditional educationally settings. Wood, Price, Laird and Robertshaw (2002) from Liverpool, UK developed a PDA-based breast cancer support tool that places the "patient as a central pivot to the content" (p. 31).

Based on a timeline metaphor, users can navigate backwards and forwards through time in relation to their current treatment, and select to receive further information where appropriate.

Collaboration

Colley and Stead (2005) have learned that while "users enjoy the content, they love the collaboration" (p. 57). They developed a tool called mediaBoard, which allows young adult learners from the mLearning project to contribute to shared websites using text and picture messaging. Learners use this technology as a facilitator for their creative ideas, thus supporting a community of practice approach.

O'Malley and Stanton (2002) evaluated the use of a variety of digital and physical technologies to support storytelling in small groups of 7 year-old children in Nottingham, UK. The tangible set-up included a 'magic carpet' to navigate through the story as well as barcodes and scanners for uploading pictures that the children draw onto a large screen. The children could also draw and input pictures using a PDA. The children were able to collaborate effectively and create physical and digital versions of stories with both pictures and sounds. The large screen was particularly effective at making everyone's actions visible to the group, and the PDAs enabled the children to switch smoothly between individual, paired and whole group activities.

The success of collaborative mobile learning in practice has led to the development of a number of theoretical models. Barker, Krull and Mallinson (2005) propose a theoretical model for the adoption of mobile learning in developing countries. They state that handheld devices can facilitate successful collaboration by allowing "learner groups to distribute, aggregate, and share information with ease" (p. 18) and include collaboration as a critical success factor in their

model. In Chile, Zurita and Nussbaum (2002) have developed a mobile computer supported collaborative learning (MCSCL) model to address problems with coordination, communication, management and lack of mobility that are inherent in traditional collaborative learning activities. Learners can interact both socially and through their wirelessly-networked handheld devices. Applying this model to collaborative learning achieves "positive interdependence, individual responsibility, mobility, group processing and face-to-face communication" (p. 65).

Interactivity

SMS, or text messaging, is widely reported as an effective tool for promoting interactivity. Stone and Briggs (2002) invited a group of 1000 university students in the UK to take place in a prize draw, which was announced to them by either email or by SMS. Only 1.6% of the email group responded, while SMS response rates ranged from 17% to 25% (with most responses received within 30 minutes of the initial request), indicating a willingness amongst students to respond to an SMS request for interactivity. Stone and Briggs suggest that this indicates that "timely, relevant support services" (p. 12) would be welcome by university students. At the University of Cape Town in Ng'ambi (2005) used SMS to address educational challenges of under-prepared students, large class sizes and diversity and add value to student learning. Students can submit an anonymous question (dynamic frequently asked question or DFAQ) by SMS, which is received by the tutor through a web interface. The response is sent back to the question author via SMS, but is also available as a resource for the whole class to view. The students can thus learn from exposure to other students' questions and the tutor receives important feedback on where students' difficulties lie.

Interactivity is also about providing opportunities for learners to respond to their environment and experiences. In a pilot of a multimedia tour at the Tate Modern in London, UK, many of the visitors' favourite stops on the tour feature a design approach involving interactive messages, "in which visitors had a chance to respond to artworks or register their opinions" (Proctor & Burton, 2004, p. 129).

Sense of Community

Mobile learning can be used to inspire the development of a community of practice approach to learning. Brandt, Hillgren and Björgvinsson (2004) describe a project at an Intensive Care Unit in Sweden in which self-produced videos are shared peer-to-peer by staff members and viewed on mobile devices. The staff members are given the responsibility for setting the content and deciding how to produce the videos. A direct impact on the success of the project has been that "the person on the video and the colleagues watching it all share the same social and cultural community of practice" (p. 27). The collaborative nature of the production process helps to make their work practices visible for more colleagues, thus enhancing opportunities for reflection and professional development.

Mobile learning can also help learners to feel a sense of belonging to the wider community. Leach, Power, Thomas, Fadani and Mbebe (2005) describe a project in which handheld computers were used to promote professional development amongst teachers in rural African settings. One of the important outcomes of this project is that it has raised the teacher's perception of their own professionalism and raised the esteem of teaching in the eyes of the community. Facer, Faux and McFarlane (2005) describe a project called The Handhelds Initiative in the UK that aimed to increase community engagement and motivation for learning.

The results of this project indicate that the handheld devices extended community access to ICT. School children taught their parents how to use the devices, which led to increased engagement with formal education by both the students and their families.

Critical Success Factors

There are many features of a project that can 'make or break' it. However, there are five that recur so frequently within the mLearn literature, that they are worthy of particular note. We have termed these features Critical Success Factors, or CSFs.

Availability of Technology

Whether provided *for*, or *by* the learner, successful mobile learning projects make mobile technology available. There are more projects to date that have relied on the provision of technology to learners, rather than employing learners' own equipment. There are many reasons for this including the need for equity, the desirability of a common platform, and the availability or otherwise of technology among the participant population.

The University of Cape Town has successfully used learners' devices, harnessing the ubiquity and simplicity of SMS text messaging on a mobile phone (Ng'ambi, 2005). In a situation where PCs were generally not found in students' homes, nor were campus clusters available 24 hours a day, 7 days a week, this ready source of hardware was very valuable. Furthermore, the students were already "communicatively competent with SMS" (p. 116), which reduced the need for training and support. Other projects have leveraged funding from specific initiatives (Butler, 2002), from government (Facer et al., 2005), investment from hardware manufacturers (Corlett et al., 2005; Cacace, Cinque, Crudele, Iannello & Venditti., 2005) or from

research programmes (Colley & Stead, 2005). Interestingly, there was rarely a long-term strategy for sustained use of technology beyond the funding horizon.

Institutional Support

Whilst one of the major benefits of mobile learning is the ability to put control in the hands of the learner, it is observed that successful projects have good institutional support. Aspects that may be seen as peripheral to a project often have significant impact. Extensive and well thought out support resources, including staff training and equipment/software maintenance are essential.

Burke, Colter, Little and Riehl (2005) cite staff training as "the most crucial element affecting success of such a project" (p. 31). Their ongoing wireless and mobile development at the University of Tennessee has seen the ubiquitous wireless coverage of the campus, extensive training of staff and technical training and support for all the students who take part in mobile-enabled classes. Use of mobile technology was not imposed on the staff, but rather provided in response to staff who worked collaboratively to develop and refine wireless teaching strategies and activities. Delivery was integrated with the institutional Virtual Learning Environment (VLE).

At Sussex University, the institutional commitment was evident in covering the costs of connectivity via a mobile operator (Luckin, Brewster, Pearce, Siddons-Corby & du Boulay, 2004). Meanwhile, the m-learning project (Attewell & Webster, 2005) saw the collective resolve of 14 organisations result in 300 disadvantaged learners receiving the opportunity to engage in a new way.

Butler (2002) demonstrated how it was necessary to see mobile learning as part of the bigger picture, not only in terms of ICT provision, but also in thinking of the user's perspectives as learning individuals, teams, organisations and communities.

Connectivity

Successful mobile learning projects incorporate wireless network access, whether through local wireless LAN, or over the mobile telephone networks. A lack of connectivity can cause significant disruption to many mobile activities (Sharples et al., 2004).

In a project to support trainee teachers with handheld computers (Wishart, McFarlane & Ramsden, 2005), access to the internet was considered to be the most valuable use of the devices for both teaching and the trainees' own learning. The ability to answer "virtually any question" (p. 186), using the device as a "distributed memory system" (p. 186) was paramount. The speed of the connection seemed less important than the ability to connect anytime and in any place. The trainee teachers found GPRS, though much slower than broadband, to be acceptable for their purposes.

At Djanogly College (Butler, 2002) as elsewhere, wireless mobile computers were used to solve the problems of space and scheduling. Here, increased access to ICT was not feasible with traditional fixed desktop solutions. Breaking with the paradigm of the 'computer room', technology became a tool to support the learning rather than an end in itself, with improvements in learner motivation and achievement being recorded.

Connectivity can be closely monitored, which makes it a useful metric for evaluating the technology. At Sussex University (Luckin et al., 2004), students were provided with mobile

devices capable of voice calling, SMS, email and internet access. Logs of data usage and messaging between students could be tracked to discover patterns of use and of collaboration.

Integration

Successful mobile learning projects do not stand apart, but are integrated with the curriculum, the student experience or 'real life', or indeed any combination of the three.

One reason for integrating closely with the curriculum is the increased engagement of teaching staff who may not be natural innovators. A clear link must be provided between what they are expected to teach and the materials and tools they use for teaching it. Facer et al. (2005) noted a risk that schools would use handhelds not because they met a specific learning need, but simply because they had them. They also pointed to significant attrition in usage as the novelty wore off. Specific ties to the curriculum would perhaps have helped to reverse this decay of interest. In higher education, it can be helpful to use mobile devices in conjunction with professionally relevant technologies, such as temperature probes for Food Technology, GPS for Environmental Science and digital cameras for Plant Pathology (Burke et al., 2005).

One way to achieve good integration with the student experience is to start with something that already exists in the learning process and use the mobile device to make the activity easier, more engaging or of greater value. At the University of Cape Town (Ng'ambi, 2005), this was achieved by taking an online FAQ system already in use, and adding the ability to interact with it anonymously using SMS. This brought greater utility and speed with anecdotal evidence of improving learning and reflection.

The Interactive Logbook Project (Corlett et al. 2005) sought to place a piece of mobile software at the centre of the student experience. Curriculum-independent, it provided a suite of

tools to support the common everyday tasks of the learner. It was then left to the learners themselves to integrate it with their own working patterns and learning styles.

The m-Learning project set out to deliver learning that was "contextualised and blended into existing, real-life learning experiences" (Collett & Stead, 2002). This was important to the design such that the learners did not see themselves as "simply 'guinea pigs'" (Attewell & Webster, 2005, p. 17). Because mobile learning met or exceeded expectations, it became a route to further learning with and about IT for many participants, rather than the disappointment or turn-off that other projects have discovered.

Ownership

Ownership of technology helps to promote ownership over learning. It is important that learners either own the technology or at least treat it *as if* they own it. This means the ability to use it any time they wish, to be free to customise or upgrade it, or even to use it subversively.

As Attewell and Webster (2005) discovered, ownership can bring with it motivational benefits – some of their learners were surprised and proud to be trusted with expensive and sophisticated technology. This in turn led to very low loss or damage rates.

Luckin et al. (2004) compared usage where one cohort of students was provided with one device each, while another cohort was required to share one between three or four. Those sharing were perceived to be at a severe disadvantage for personal communication. Facer et al. (2005) noted that where the handhelds were given to new groups of school pupils each week, limited options existed for personalisation of the devices. Conversely in the same study, even where teachers stopped using the devices to support curriculum, some pupils continued to use them for personal activities including personal organisation and diarising.

Given the opportunity, students will use mobile devices for entertainment and socialising as well as for educational purposes (Corlett & Sharples, 2005) – even watching movies or messaging friends during formal lessons. However, where this occurs, the student is likely to make more use of the device for learning purposes than they would otherwise. The same study also noted that technologies compete for the user's attention. Students with their own mobile devices were less likely to use loan equipment, even if it was considerably more sophisticated, since they had already invested money and time in acquiring and personalising their own.

It may be necessary to allow usage of the technology beyond a given trial in order to guarantee participants' loyalty to the project and the technology. Burke et al. (2005) pointed out the dangers of making a portable computer central to a student's learning style, only to take it away again before the course or programme is completed.

Challenges for Educators and Technology Developers

The mLearn literature is rich with complaints about the challenges facing mobile learning. Along the way, however, we have discovered some helpful pointers, with a few recommendations for future work common to many projects. We have tried to remain solution focused and consequently have picked out papers that help to shape thinking towards overcoming these challenges.

Improving Technical Reliability

There are many documented problems with the reliability of mobile devices, in particular handhelds. These include battery life, network connectivity, data loss and compatibility. Nearly all empirical trials have concluded with recommendations being made for improved

dependability. Facer et al. (2005) are among those who noted the waning of engagement by pupils as devices began to malfunction throughout a project.

Some projects developed strategies for overcoming difficulties with, for example, data loss, whilst other researchers would endorse the need to thoroughly test before use. Burke et al. (2005) found that even basic technologies such as SD or USB flash drives did not have universal compatibility, meaning that activities had to be restructured at the last minute to accommodate this.

There would seem to be a pattern that projects using simple and user-owned technologies have the fewest problems with reliability (see, for example Ng'ambi, 2005).

Building Teacher Confidence

Reflecting on their projects, many authors recognise lack of teacher training and experience as a factor in poor execution. Confidence, not only in the technical aspects, but also the educational value of handhelds is necessary, but sometimes lacking. To make good use of mobiles in the classroom requires a confident teacher. Teachers who lacked confidence with the technology were unlikely to use it in front of pupils (Wishart et al., 2005). Teachers may begin with an assumed confidence in the pupils' or students' abilities, but often this is unfounded (Burke et al., 2005). Self-declared competencies either do not match reality or cannot necessarily transfer to novel applications.

Interestingly, the m-learning trials discovered that there was no significant difference in outcomes whether tutors had extensive training and time to practice or not. In both cases, tutors expressed a sense of unpreparedness. However, it seems that the tutors' considerable commitment to the overall project may have transcended technical concerns.

Rethinking Mobile Learning Design

Learning design is important and in most cases a direct conversion of existing methods does not work. The mLearn literature is rich with suggestions of design principles, a few of them being:

- Create quick, simple interactions (Corlett et al., 2005; Luckin et al, 2004).
- Prepare materials that are flexible and can play to the heterogeneity of learners (Frohberg, 2005). Mobility means that the context of even one individual will keep changing, thus varying his or her needs (Morken & Divitini, 2005).
- Design access and interactions that account for the heterogeneity of devices and standards (Mattila & Fordell 2005), particularly taking account of presentation and input capabilities (Ally, Lin, McGreal & Woo, 2005; Graham, Bowerman & Bokma, 2004; Popat & Stead, 2005) .
- Consider a different approach to design, such as the use of non-functional requirements (NFRs) to match key user requirements to the capabilities of a device (Avellis, Scaramuzzi & Finkelstein, 2004).
- Consider special affordances (or even perceived limitations) of mobile devices that might add to the learner experience. Ng'ambi (2005) demonstrated this through using anonymity to empower questioning.
- Use mobile technology to not only 'deliver' learning, but also to facilitate it, since native applications (note-taking and time management for example) are well suited to this (Baber, Sharples, Vavoula & Glew, 2004; Corlett et al., 2005).

- When converting content from previous uses, take a staged approach to reviewing and repurposing it. (Rodin, 2005) This will identify problems early in the process.
- Apply Learner-Centred Design (Danielsson, Hedestig, Juslin, & Orre, 2004), since the teacher-centric model apparent in many learning environments is not appropriate.

Reducing Cost of Use

Not only the cost, but also the *perceived cost* of mobile learning must be reduced. Equipment and connectivity are only pieces of the cost equation, with development of tools, content and training playing a major part.

Connectivity costs using mobile networks can be high, but also not very transparent. Data is usually charged by the kilobyte, which is not easy for the user to translate into real activities (opening a web page, watching a video, sending an email). Tools to measure data usage are still poor and users are inclined to be overly cautious rather than risk a large bill (Luckin et al., 2004).

Keegan (2005) points to the revenue opportunities afforded by mobile learning. However, these are yet to materialise and the mobile operators are yet to see or understand viable business models linked to education. This is an important area for future development as mobile learning projects transition into mainstream education.

Future-Proofing

Mobile technology is a commodity product, presenting a significant challenge for learning designers. Knowing what will be fashionable, reliable, usable and available even in the coming year is at best guess-work.

To make the guesses more reliable, it is worth doing research to chart out a 'road map'. Attewell and Webster (2005) used this approach in the m-learning project to anticipate changing factors over the life of the project. These included delivery options, platform, media options, development languages and transport options.

Content can be created that is independent of the delivery mechanism. Arias, Reichenbach and Pasch (2005) describe a mark-up language used to package video with other materials and be delivered in the best possible way for a given target device.

One way to anticipate where technology will be going is to pay attention to international standards. Standards already apply to many aspects of eLearning, though there are none specifically governing mobile learning. Veith and Pawlowski (2005) have looked at how these standards can be tailored appropriately and have outlined the benefits to learners and authors by adopting them. Of course vendors do not always (or even mostly) adopt standards, unless there are market forces demanding them.

Summary and Conclusions

We hope this paper is an encouragement to those engaged in mobile learning development and a primer to those planning to embark on it. We also hope it will act to draw a line under what has been discovered to date and raise the bar for future projects.

First, we drew together the positive outcomes of successive projects and by triangulating the findings demonstrated that there are specific and verifiable benefits to mobile learning. Second, we showed that these outcomes are not automatic; to ensure even some of them requires paying careful attention to the features of what made the projects successful – the CSFs. Third, we recognised that there are still challenges that we as a community are beginning to understand,

but do not necessarily have solutions to yet. By considering these challenges, practitioners will reduce risk and by embracing them, educationalists and technology developers can add value to the growing body of research.

The principles that have been revealed and confirmed over many projects should, if adopted, serve to ensure a new minimum standard in undertakings while limiting the extent of unnecessary reinvention.

References

Ally, M., Lin, F., McGreal, R. & Woo, B. (2005). An Intelligent Agent for Adapting and Delivering Electronic Course Materials to Mobile Learners. *Mobile Technology: The future of learning in your hands,* Cape Town, 1-5.

Arias, R., Reichenbach, M. & Pasch, G. (2005). XML saves the day: Porting a Rich-Media Collection to a Mobile Platform in Three Weeks Flat. *Mobile Technology: The future of learning in your hands,* Cape Town, 8-13.

Attewell, J. & Webster, T. (2005). Engaging and Supporting Mobile Learners. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 15-19.

Avellis, G., Scaramuzzi, A. & Finkelstein, A. (2004). Evaluating non-functional requirements in mobile learning contents and multimedia educational software. *learning with mobile devices: research and development*. London: LSDA, 13-20.

Baber, C., Sharples, M., Vavoula, G. & Glew, P. (2004). A 'learning space' model to examine the suitability of different technologies for mobile learning. *learning with mobile devices: research and development*. London: LSDA, 21-25.

Barker, A., Krull, G. & Mallinson, B. (2005). A Proposed Theoretical Model for mLearning Adoption in Developing Countries. *Mobile Technology: The future of learning in your hands,* Cape Town, 17-22.

Bradley, C., Haynes, R. & Boyle, T. (2005). Adult Multimedia Learning with PDAs - The User Experience. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 23-27.

Brandt, E., Hillgren, P-A., Björgvinsson, E. B. (2004). Self-produced video to augment peer-to-peer learning. *learning with mobile devices: research and development*. London: LSDA, 27-34.

Bull, S., Bridgefoot, L., Corlett, D., Kiddie, P., Marianczak, T., Mistry, C. et al. (2005). Interactive Logbook: the development of an application to enhance and facilitate collaborative working within groups in higher education. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 39-42.

Burke, M., Colter, S., Little, J. & Riehl, J. (2005). Utilizing Wireless Pocket-PCs to Promote Collaboration in Field-based Courses. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 28-31.

Butler, M. (2002). Wireless Networks Case Study: Djanogly City Technology College Nottingham. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 57-60.

Cacace, F., Cinque, M., Crudele, M., Iannello, G. & Venditti, M. (2005). The impact of innovation in medical and nursing training: a Hospital Information System for Students (HISS) accessible through mobile devices. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 47-52.

Cereijo Roibás, A. & Arnedillo Sánchez, I. (2002). Pathway to m-learning. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 53-56.

Colley, J. & Stead, G. (2005). Mobile learning = collaboration. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 57-58.

Collett, M. & Stead, G. (2002). Meeting the Challenge: Producing M-Learning Materials for Young Adults with Numeracy and Literacy Needs. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 61-62.

Corlett, D. & Sharples, M. (2005). Tablet technology for informal collaboration in higher education. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 59-61.

Corlett, D. Chan, T. Ting, J. & Sharples, M. (2005). Interactive Logbook: a Mobile Portfolio and Personal Development Planning Tool. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 32-36.

Danielsson, K., Hedestig, U., Juslin, M. & Orre, C. J. (2004). Participatory design in the development of mobile learning environments. *learning with mobile devices: research and development*. London: LSDA, 47-53.

de Crom, N. & de Jager, A. (2005). The 'ME'-Learning Experience: PDA Technology and eLearning in Ecotourism at TUT. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 37-44.

Facer, K., Faux, F. & McFarlane, A. (2005). Challenges and Opportunities: Making Mobile Learning a Reality in Schools. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 53-56.

Frohberg, D. (2005). Mobile learning in tomorrow's education for MBA students. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 81-84.

Graham, P., Bowerman, C. & Bokma, A. (2004). Adaptive navigation for mobile devices. *learning with mobile devices: research and development*. London: LSDA, 61-67.

Holme, O. & Sharples, M. (2002). Implementing a Student Learning Organiser on the Pocket PC Platform. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 40 – 43.

Kay, A.C. (1972). A personal computer for children of all ages. *Proceedings of the ACM National Conference*, Boston.

Keegan, D. (2005). The incorporation of mobile learning into mainstream education and training. *Mobile Technology: The future of learning in your hands,* Cape Town, 65-70.

Leach, J., Power, T., Thomas, R., Fadani, X. & Mbebe, A. (2005). 4D Technologies: Appropriating Handheld Computers to Serve the Needs of Teachers and Learners in Rural African Settings. *Mobile Technology: The future of learning in your hands,* Cape Town, 95-102.

Luckin, R., Brewster, D., Pearce, D., Siddons-Corby, R. & du Boulay, B. (2004). SMILE: the creation of space for interaction through blended digital technology. *learning with mobile devices: research and development*. London: LSDA, 87-93.

Mattila, P. & Fordell, T. (2005). MOOP - Using mLearning Environment in Primary Schools. *Mobile Technology: The future of learning in your hands,* Cape Town, 107-111.

Morken, E.M., & Diviniti, M. (2005). Blended mobile and ambient technologies to support mobility in practice based education: the case of teacher education. *Mobile Technology: The future of learning in your hands,* Cape Town, 45-49.

Naismith, L., Sharples, M. & Ting, J. (2005). Evaluation of CAERUS: a Context Aware Mobile Guide. *Mobile Technology: The future of learning in your hands,* 112-115.

Ng'ambi, D. (2005). Mobile Dynamic Frequently Asked Questions (m-DFAQ) for Student and Learning Support. *Mobile Technology: The future of learning in your hands,* Cape Town, 116-119.

O'Malley, C. & Stanton, D. (2002). Tangible Technologies for Collaborative Storytelling. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 3-6.

Popat, K. & Stead, G. (2005). m-learning via the web: the challenge of size. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 167-169.

Proctor, N. & Burton, J. (2004). Tate Modern Multimedia Tour pilots 2002-2003. *learning with mobile devices: research and development*. London: LSDA, 127-130.

Ragus, M., Meredith, S., Dacey, D. Richter, C., Paterson, A. & Hayes, A. (2005). The Australian Mobile Learning Network: Australian Innovations. *Mobile Technology: The future of learning in your hands,* Cape Town, 130-137.

Rodin, L. (2005). E-learning to m-learning: an investigation into the potential for content conversion. *Mobile learning anytime everywhere: A book of papers from mLearn 2004*. London: LSDA, 171-175.

Sharples, M. (2000). The Design of Personal Mobile Technologies for Lifelong Learning. *Computers and Education*, *34*, 177-193.

Sharples, M., Corlett, D. & Westmancott, O. (2002). The Design and Implementation of a Mobile Learning Resource. *Personal and Ubiquitous Computing*, *6*, 220-234.

Sharples, M. Chan, T., Rudman, P. & Bull, S. (2004). Evaluation of a mobile learning organiser and concept-mapping tools." *learning with mobile devices: research and development*. London: LSDA, 139-144.

Stone, A. & Briggs, J. (2002). ITZ GD 2 TXT – How to Use SMS Effectively In M-Learning. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 11-14.

Swan, K., van't Hooft, M., Kratcoski, A. & Unger, D. (2005). Teaching and Learning with Mobile Computing Devices: Closing the Gap. *Mobile Technology: The future of learning in your hands,* Cape Town, 157-161.

Veith, P. & Pawlowski, J. (2005). Conception and Development of Reusable and Modular Mobile Content. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 171-175.

Wishart, J., McFarlane, A. & Ramsden, A. (2005). Using Personal Digital Assistants (PDAs) with Internet Access to Support Initial Teacher Training in the UK. *Mobile Technology: The future of learning in your hands,* Cape Town, South Africa, 182-187.

Wood, J., Price, G., Laird, D., Robertshaw, S. (2002). Mobile devices for breast cancer care: A Personalised Education Information Profiling System (PEIPS). *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 30-31.

Zurita, G. & Nussbaum, M. (2002). Mobile Computer Supported Collaborative Learning: MCSCL. *Proceedings of the European Workshop on Mobile and Contextual Learning*, Birmingham, UK, 65.