M-learning as a means of supporting learners: tomorrow's technologies are already here, how can we most effectively use them in the e-learning age?

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ABSTRACT

Mobile telephone ownership and usage is now almost ubiquitous amongst student communities, but until now has been largely passed over as a technology for supporting student learning. As increasingly powerful networks and handsets are developed, it is claimed that "m-learning" (mobile learning) will be one of the largest applications - but the potential of what can already be achieved has hardly been explored. This paper first explores the notions of complementary media and complexity. A survey of work undertaken globally illustrates how others have already attempted to apply Short Message Service (SMS) and Wireless Application Protocol (WAP) technologies in libraries and teaching. We summarise results of research recently completed at Kingston, adopting a learner-centred approach to forthcoming research and trials using current and future technologies.

Keywords

Mobile learning, ubiquitous computing, grounded theory, complementary media, digital library, learning support

INTRODUCTION

In recent years, we have seen a staggering rise in the ownership and use of mobile telephones. In addition to allowing voice calls to be made, Short Message Service (SMS) allows short (160 character) messages to be sent to others, typically within a very short space of time. The use of SMS messaging has grown at a phenomenal rate - at the time of writing, over 1 billion text messages are sent every day. One of the major demographic groups which has adopted this technology the quickest is that which covers the typical age range of students in higher and further education. Whilst this hints towards significant potential for research in how such a technology can be used in supporting learning, we must not be blinded by marketing claims and hype.

This paper first explores the notions of complementary media and complexity. We then survey work undertaken globally, that illustrates how others have already attempted to apply SMS and WAP technologies. These applications can be divided into two main strands: in libraries and teaching. Within these strands, we highlight some of the characteristics of interest to us, citing results from the original studies where relevant. We should point out at this stage that it is our belief that SMS is the best candidate technology over WAP at present, in terms of what we feel is a de facto standard in use by students, and our most immediate applied work reflects this. However, we acknowledge the work done to date in both WAP and SMS development, but maintain SMS is the more suitable technology for our current work.

Having devoted a large amount of space to summarising the developments to date using mobile technologies, we present the results of our research at Kingston University, which adopts a learner-centred approach to forthcoming research and trials using current and

future technologies. Many of us have a background and commitment to both user-centred design and optimising pedagogic outcomes and techniques. By taking a learner-centred approach to our research on Information and Communications Technology (ICT) as a whole, benefits can be gained from marrying this with the notions of complementary media, complexity, and how mobiles can be used to support learners. We finish by mentioning a few caveats with this approach, in acknowledgement of the fact that no novel use of technology is without its potential pitfalls(!), and conclude by inviting those interested to join us in this research.

Complementary media and complexity

Common sense dictates that people use technology that is appropriate for the task. For example, if the person that you want to speak to is not in near proximity one uses the telephone to talk to them. Furthermore, documents for discussion at a meeting are often circulated before a face-to-face meeting. This might be done by post, fax or email. Within such decisions individuals have their preferred technologies and mixes of these. For example, many colleagues of ours like documents to be emailed to them prior to such meetings. It is in this sense that complementary is meant. It encompasses appropriateness, mix and individual choice. However, there is a caveat.

Sometimes the availability of the appropriate technology is an issue, i.e. it is not available and then finding an appropriate alternative is, in fact, what is happening. For example, the telephone in the example above is used because the face-to-face option is not available. The telephone is the best scenario within the options available.
Such a notion of complementary sits comfortably with the fact that individuals operate in complex environments. Consider the environment of a driver in a car wishing to use their mobile phone while driving. The need for a hands free kit evolves. This is just a change in the physical environment. Whilst driving involves thought one learns little new about driving over the years. However, the 'learning environment' of learning to drive is far more complex than just driving.

The literature backs up this notion of complexity. Fritze suggests that with the complexity of learning comes the great need for qualitative evaluation of its use (Fritze, 1994). Even now this need is still apparent to the extent that the ESRC are explicitly funding the building of a larger capacity to undertake quality evaluation. Without this richness one cannot be sure what is actually taking place.

This context of the complexity of learning brings with it the suggestion that multiple-media is required to meet its demands (Heeren, 1997). Heeren considers two theories: Activity and Media-richness. The former considering intentions, motivation and how actions take place (p.89, op cit.). The latter, from Daft and Lengel (in Heeren, op cit.), considers how richer information the media can carry. Four dimensions are outlined: interactivity, the opportunity for multiple clues, the variety of languages and the ability to convey social-emotional clues. Here it is suggested that there is a need for multiple media at different times. Whilst this is not challenged, but supported, there is an irony for humanity in M-Learning. The ability of humans to adapt to and adapt technology for uses that would not previously be considered.

It is here that the research team finds inspiration, and to a degree follows Collis' idea that such adaptation for learning ought to be 'Learning Needs Centred' (Collis, 1997). It is not attempted to cover the richness of the discussion of collaborative learning and multimedia undertaken, but the idea of multimedia fitting the needs of the learner fits comfortably with the idea of complementary media and complexity.

Within this focus it is well worth remembering that learners use 'old strategies' to learn the use of new technologies (Psotka et al, 1994). This can lead to innovative, unexpected but intended uses. William Gibson (the science fiction author credited with the invention of the term "cyberspace") remarked via one of his characters in "Virtual Light" (Gibson, 1993), "The street finds its own use for things", referring to high technology in particular. It is our belief that the networked learning environment (and its practitioners!) should take this attitude on board. Rather than merely considering "cutting-edge technology", we are more interested in what we call "appropriate technology", i.e. delivering what is of most use to people, using technologies they already have, and that they are already familiar with. For example, mobile telephones.

Why should we bother with mobile phones - aren't they just a nuisance?

As we move towards increasingly powerful networks and handsets, the "m-learning" bandwagon gathers increasing momentum - but the potential of what can already be achieved has hardly been explored. Whilst we are looking towards the future (e.g. the 3rd and 4th generation of mobile technologies, future generations of networked Personal Desktop Assistants (PDAs) and other forms of pervasive computing) into our educational technology strategies and R&D efforts, we strongly believe in considering (and developing) what can be achieved to support our students *now*, with currently used, popular, and ubiquitous technologies.

Current perceptions of mobile phones in education are typically negative: they are seen as a distraction in today's learning environments (a source of unwanted noise through ringtones, text messages, and conversations), hindering students from working effectively. However, to ignore the unprecedented growth of a single communication technology amongst the student population is

to admit defeat - we have the potential to harness what is *de facto*, a ubiquitous wireless network that is in active and frequent use amongst the student population!

Review of SMS/WAP technologies in education

Having outlined the theoretical basis underpinning our interest in exploring mobile phones for learning support, we pause to review how SMS and WAP technologies (available in the current generation of handsets in use by students) has been used to date to support learning and teaching. In this, we include library applications, which are now a rapidly growing area of development. Happel observed the "gigantic potential for the development of services" (Happel et al 2000), predicting the trend of using email notifications in software applications being converted to SMS, citing "younger users and teenagers" as the main expected user group (op cit.). We begin with a review of work done in the libraries sector, then consider learning support applications. This section concludes with a brief discussion of the future of WAP and SMS (including next generation messaging systems, including EMS and MMS).

Examples of SMS and WAP supporting libraries

There have already been a number of isolated trials using SMS and WAP to support libraries. The Wiener Stadt-und Landesbibliotek in Austria has been reported as being one of the first in Europe to offer. (Happel et al, 2000) WAP-enabled catalogue access. Finland's ATP Origo system is reported to be capable of dealing with overdue books and renewals via SMS, and proposes using WAP for search, renewal, and request facilities (Biblio Tech Review, 2000).

Some library systems do not yet offer preconfigured mobile solutions, but may offer a facility that allows developers or third parties to add such functionality. Whilst this allows flexibility for technically skilled individuals to forge ahead with their own solutions, it can be difficult to scale up from a successful project – particularly with providing support.

The Birmingham University-led BUILDER project (from which the Talis library system emerged) had a "toolbox" (Talis Project, 2000). This was a socket-based Application Programming Interface (API) which enables web applications to access information stored in the Talis Library Management System – including works, items and borrowers. This API also allows the potential to have SMS (and WAP) integrated, giving potential for independent developers to add to the core product purchased by their institution. However, this means such extensions will be unsupported by the vendor, and are reliant on the goodwill of the developers in the absence of funding and commitment. Similarly, the toolbox itself was not integrated into the Talis product, as subsequent updates to the core product would have meant further development work on the API. Talis have, however, developed a product that integrates with Managed Learning Environments (known as MLEs).

In addition to library systems companies offering SMS/WAP modules, other companies have decided to offer off-the-shelf solutions that are designed to work with existing library systems. New Zealand-based Talking Technologies (Talking Technologies, 2001) offer a product that claims to allow account access and manipulation (renew books, review standard library messages, speak to a member of library staff), and outgoing messages; e.g. message sent direclty to a borrower's voicemail/SMS. The German company SISIS (Sisis News, 2001), in conjunction with Dresden urban libraries, have offered SMS notification services (i.e. when reserved items arrive; forthcoming renewal dates on items; references to meeting and new offers). They are also offering such alerts via email.

Examples of SMS and WAP supporting learning

In addition to library support, SMS and WAP technologies have been used to support learning.

For example, there is a partnership between a Singapore-based e-learning company and an Australian training company, which has used WAP devices to access summaries of information, short quizzes, and listen to lectures on the move (Turner, 2001). About 30% of course content was made available in this way - the academic director was quoted as saying "the technology is... not meant for heavy-duty learning... you cannot take a whole course over a WAP telephone". Whilst the usefulness of adding WAP technology to their courses was acknowledged as a form of complementary media, it is not expected to be a replacement.

Noone alerts us to a partnership between a company called ICUS, the INSEAD business school, Nokia (who were reported to have invested $500,000 in the project), and a Singaporean telecommunications company (Noone, 2001). This partnership intends to use the web and WAP to develop a model that can be sold to other companies. A Word document cross-referencing WAP chunks and web topics was used as a navigational aid; 10% of the course was WAP-only, but 80% of the overall course was accessible via phone (e.g. links to WAP sites, quizzes, and reminders and alerts from lecturers). The user reactions were more favourable than expected, with most learners accessing 40-50% of WAP-delivered material, and 70-80% of Web-delivered material. The main objection to WAP was the constraint of the small screen size, although the timeliness of information was regarded as a great benefit. We find it interesting to note that a Word document was chosen as a navigation aid, perhaps another instance of "appropriate

technology" in the midst of more cutting-edge developments.

Aligonby (2001) reported that Temasek Polytechnic in Singapore was planning to move from paper distribution of student results, sending text messages instead. It was estimated that 80% of the 13,000 full-time students have mobile phones, and this would offer substantial cost and efficiency savings (although those who do not opt in still receive results through conventional post or via a website). In the same article, another university deployed a similar results service using WAP, which was found to be less popular. It is proposed that this may be because these students had to pay for the service, whilst the SMS service was free, but comparison of these two cases is unrealistic, as there is a difference in the pricing model used, and substantial differences between using SMS and WAP. However, we feel that given students pay for each text message sent, and they are avid users of the service, we are more inclined to speculate that usability issues may count for more in our trials, than the pricing model employed.

A system that is hard to use, whether it is free of charge or not, is less likely to be used than one that is easy to use by those it is aimed at. Furthermore, we do not expect to discuss how much a system is worth to users until we have established it is something they feel has a positive benefit for them. In economics jargon, we wish to establish utility exists for a service, before we begin to determine issues such as demand and its elasticities. In order to consider such issues, though (and we do need to address them at some stage, particularly if trying to scale up the size of a prototype), we need to be aware of the context of the direction the technology is heading, and what is likely to replace *today's de facto* standards. The following sub-section considers where we are now, and where we are likely to be going next.

Aside – a brief discussion on current and future technologies

It is interesting to compare library developments using SMS and WAP to those aiming to use these technologies to support teaching and learning: at the time of writing, much of the reported work in learning and teaching support has taken place in the Australasia and the Far East. The library systems, in contrast, appear to have a European bias.

Amongst the learning and teaching support work reviewed, much of it involves WAP; and it is mainly aimed at business-oriented postgraduate learners. However, we acknowledge this is a useful early adopter community, which can be used to trial applications and services using the newer technologies as they come on to the market (as this group is most likely to have them first).

One of the major drawbacks of WAP is its relatively low user base compared to SMS, combined with a generally indifferent public reaction to the services offered at its launch. The marketing of WAP led people to believe that they would be getting something like the internet on their handset, and over-inflated public expectations. Buchanan et al (2001) make some good recommendations based on user-centred design approaches to improving WAP services, which may mean that future WAP services may have a greater take-up rate than before, and we welcome such efforts. However, we feel that the ubiquity of SMS at this time amongst students will ensure the highest degree of participation possible.

A review on current and forthcoming mobile technologies (Mobile Streams, 2001) indicates SMS is the first stage in increasingly richer messaging. Soon we will be able to send longer messages, including basic graphics capabilities, and able to use different ringtones to indicate if a message is, say, related to a library, teaching, or personal matter. At present, though, the technology that is in most common use and accepted by users (including students) is SMS. We believe that even with this relatively modest technology, this is adequate to develop tools to complement students' learning activities, in similar ways to those they feel MLEs most strongly benefit them. The next section outlines some of the research we have done that supports this claim.

KU research

Recent research at Kingston University has established that students are most interested in using technology to better manage their time (Kingston University Library 2001, Alsop et al, 2001). A company, with which the Learning Technology Research Group has strong links with, has undertaken applied research trials (Briggs and Smith, 2001) which focused upon which combinations of SMS, email and web forms elicit the highest response rate amongst students. This has included data to inform how to maximise completion of a task, and detailed analyses addressing the duration and rate of responses from the initial time of sending interactive content. This expertise allows us to develop a roadmap of work that is most likely to be of use to students, optimise system design and timely interactions, and thus maximise participation.

We are engaged in the development of a theory grounded upon students' current and perceived future usage of mobile telephony. We are identifying the combinations of technologies that students use, determine the contexts of use, to what extent students are already using these to support their learning activities, and which combinations they use (and how) when presented with more options. We are using these results to inform subsequent work, in addition to trialling applications which integrate with information and communication technologies (ICT) already in use: e.g. using information screens on campus; the managed learning environment (MLE) deployed across the university.

We also intend to explore stakeholder perceptions of different pricing models; very informal conversations with (an admittedly small number of) students have indicated there may be a willingness to pay for certain services, although others may be expected as part of what is expected from the university (i.e. for free). Also, we are working with our industrial partners to explore the potential of the next generation of mobile networks and handsets.

Some caveats

Whilst we are actively engaged in research to explore how m-learning can be most effectively be used and deployed, we are aware that the use of mobile telephones to support libraries, teaching and learning is not a flawless "silver bullet"; here we offer (and acknowledge) three of the main caveats.

- Text messaging is not free. Cost issues mean that services have to be thought through - the 'right' applications can result in considerable savings; but information provision services will cost. Our research will gain an understanding of what students may be willing to pay for, and how (many different pricing models exist).

- SMS infrastructure has an inherent risk of not being timely(!). But we agree with Jacobsen and Johansen (1999) that SMTP/HTTP (i.e. use of email and web as complementary media) is the best interim solution. This also addresses the issue of inclusiveness - every student at Kingston University (and others) has access to email and the internet.

- Whenever new technologies are being used in a project, it is inevitable that a dependency exists on the hardware suppliers, in terms of their commitment for the duration of the research project. DuVall (2001) reports on the OWLS project in the USA, which involves the use of Handspring PDA devices, but also used Ericsson mobile phones at the start. Elsewhere on the website, it appears that Ericsson withdrew substantially from the project, as they were to "no longer support the education and training sectors as one of their core business areas". However, this risk appears to have been successfully managed, by a move towards using PDAs. We feel it is prudent to develop a strategy that allows flexibility with respect to delivery platforms, particularly when considering the newest generations of technologies.

Conclusions

The outcomes of our work will identify how the use of different technologies can be used to maximise the potential of M-Learning. We are interested in feedback from interested parties: critical appraisals of our work, and collaborative partnerships in both theoretical and practical research.

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