FROM ELECTRONIC TO MOBILE LEARNING
How to Make the Most of Existing e-Learning Materials in Wireless Environment

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Abstract: Continuous advancement of mobile devices and wireless communication technologies can be successfully utilized to complement face-to-face and blended learning methods. In the recent years various educational software systems have accumulated a wealth of learning resources. Proliferation of mobile devices offers new ways for content delivery. The aim of the project described in this paper was to avoid re-development of the existing online teaching resources and investigate their effectiveness in mobile learning. We have surveyed students' expectations in terms of educational methods and materials students preferred to use ubiquitously in synergy with face-to-face or blended learning. The study provided an impetus towards the development of a J2ME platform conveying existing electronic teaching resources from the LMS to mobile devices. The analysis of students learning effectiveness via mobile devices has shown the benefits of enriching student experience by means of new technology. This paper concludes with a reflection on the user experience and guidelines for conveying and adaptation of the existing online learning materials for wireless delivery.

1 INTRODUCTION

Recent developments of information and communication technology have been widely adopted by academics and corporate market to support e-Learning. Over the past decade a wide range of software systems enabling e-learning have emerged providing capabilities for management of didactic content, online assessment, collaborative learning, etc. A great majority of e-learning software leverage proven web-browser interface via a network connection to an application server. New products for e-learning support continue to emerge providing new capabilities and others combining existing functionalities. Academic institutions have widely adopted *Learning Management Systems(LMS)*(Sun Microsystems, 2003), which are intended to help sequence educational content and create a manageable structure for instructors and students, offering the use of collaborative environments and other distributed learning technologies. Such LMS products as BlackBoard/WebCT, Moodle, and Desire2Learn have become a de facto requirement in most universities. As a part of a well-planned educational strategy e-learning can deliver very effective results and increase student satisfaction (Maise, 2001).

Numerous LMS products deployed in education over the years have accumulated a vast amount of learning resources in the form of legacy HTML content, multimedia resources, and other electronic teaching materials. Until recently, e-learning relied on content delivery through a web browser interface on a wired computer connected to an LMS server. Increasingly this is being challenged (Maise, 2001). Proliferation of portable devices and increased speed of wireless connection allow a wider interface to educational content. *M-learning*, the mobile equivalent of e-learning, is an emerging field of research, being enthusiastically embraced by manufacturers, content providers, and academics. More and more people, especially among young population, are carrying mobile computing devices in the form of smart phones, PDAs, etc. everywhere they go. The opportunity to offer new ways of interacting with information by means of wireless gadgets already on hand of learners seems

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compelling to educational practitioners. We consider the services and possibilities that mobile devices offer as promising especially when it comes to the development of new learning methods and didactic forms. Learners on the move can use mobile devices to access their learning materials anywhere at any time. The challenge addressed by this paper is how to make the most effective use of existing online educational content for mobile access.

Recent studies suggest (Stern et al., 2005) that in many cases resources spent on development of online materials exceed their benefits, and more attention should be paid to how students actually use pedagogical software. It seems that with the arrival of new technologies pedagogical resources undergo complete re-engineering. From legacy HTML content, a move towards multimedia-based content created redundant information with a variety of conflicting standards. The advent of wireless access generated a move to designing educational resources suitable only exclusively for m-learning (Sharples, et al, 2002).

Very little attention has been directed towards the cost effective combination of e-learning and m-learning. Which learning content shall and can be accessible to the learner, provided in which amounts and portions and in which media type? How can we ensure that learners gain access to the relevant didactic resources and services which can be used under the given requirements of mobile learning? Another question is about the usability of available resources suitable for mobile settings. This paper suggests a flexible J2ME-enabled software architecture that optimizes commonly used online LMS materials for wireless delivery. We present our findings regarding students' expectations and user acceptance of m-learning features. Compared with traditional or even electronically enabled learning, technology supporting mobile learning is still viewed as innovative by most teachers and students. Therefore, developing appropriate guiding models for effective implementation is the key for m-learning to progress from the research stage to practical use in the future. First we introduce the results of a study of LMS usage by undergraduate Information Technology students, which surfaced critical LMS content and access points deemed effective by the learners. Further we have investigated students expectations in terms of educational methods and materials students preferred to use ubiquitously in conjunction with face-to-face or blended learning. The study provided an impetus towards the development of a J2ME platform conveying existing electronic teaching resources from the LMS to mobile devices. Quantitative analysis of students learning effectiveness via mobile devices has shown the benefits of enriching student experience by means of new technology. We conclude the paper with a reflection on the user experience and guidelines for conveying online learning materials for wireless delivery.

2 WHAT STUDENTS REALLY USE FOR LEARNING

The convergence of mobile communications and handheld computers offers the opportunity to develop technology that can assist individuals and groups to learn anytime, anywhere. New forms of learning have an enormous power to enrich students' experience through the use of interactivity and multiple media (Maise, 2001). As shown by recent surveys (Stern et al., 2005) interactive mode of learning has a direct impact on learning effectiveness and student retention, as compared to learning through reading, for example. Many research studies have uncovered that learning challenging topics through hypermedia environments present difficulties to students (Azevedo, 2005).

Recent empirical studies have suggested the advantages of using wireless technologies and mobile devices in learning environments, including engaging students in learning-related activities in diverse physical locations, supporting group work on projects, and enhancing communication and collaborative learning in the classroom. Concentrating on mobile access has forced us to think carefully about what LMS capabilities and content sections are essential for effective learning. In this paper we have explored which LMS components are critical for effective asynchronous learning, such as exam review or preparation for a laboratory exercise by one hundred undergraduate Information Technology students.

2.1 Methodology

Over the duration of an academic semester we have collected statistical information regarding the usage of LMS components for asynchronous study mode. Students have been presented with the educational content structured into units of textual content, enriched with interactive activities, followed by multimedia summary points and visualizations of

computer interaction by the instructor. The LMS materials have complimented face-to-face practical teaching sessions. Students have been instructed to use online materials as a source for self-study ahead of the hands-on tutorials. These materials have been available throughout the entire semester and were used for final assessment preparation by the students. Figure 1 shows the functional elements available on the LMS including textual; learning objects, activities, summary, and other components linked together to comprise a cohesive learning unit. Usage statistics for 100 undergraduate students has been collected and comparatively analyzed.

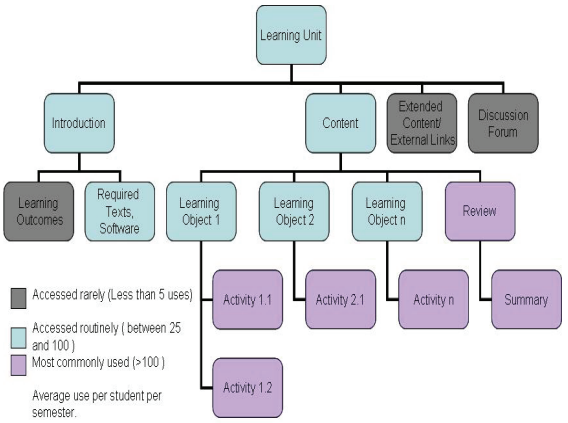

Figure 1: Online Learning Materials: Use of Functional Elements on LMS.

Through the analysis of the usage statistics we have identified the learning paths which students developed in their learning strategy. Most common components on the LMS accessed and used by students in asynchronous mode were activities, summary and review elements, textual content and introductory elements were accessed less frequently, followed by discussion facilities and extended content elements.

The analysis of which materials students use most on the LMS identified the critical components that may provide an effective way of learning if made available for mobile access. In addition to the analysis of the LMS statistics, students participating in this study, have been surveyed on their expectations and general acceptance of m-learning. The survey results have surfaced that ninety eight percent (98%) of participants would like to try accessing e-learning content on their mobile devices. However fifty nine percent (59%) of respondents have voiced concerns over the limitations of the mobile devices they owned. Twenty three percent of them (23%) noted that the small size of the screen may hinder the effectiveness of m-learning, with nineteen percent (19%) of respondents being concerned with spending too much time searching for the necessary learning element. Only ten percent (10%) of the surveyed students mentioned the speed of wireless connection being critical to accessing learning materials. Finally, students have been asked to identify and prioritize learning objects available on the LMS they find potentially useful for ubiquitous learning. The results have surfaced that students prefer to have mobile access to content rich materials, such as visual/multimedia components (78% of the respondents), textual content (26%), review exercises/questions (52 %) and summaries (32%).

Based on these findings critical learning content used by students on wired LMS was integrated for access on mobile devices. Content-rich materials included video segments capturing use of web design software and relevant concepts, textual content summarized in multimedia vignettes and diagrams, and other visual learning materials as shown in figure 2.

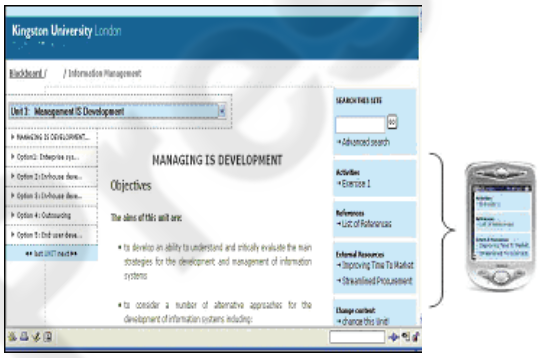

Figure 2: LMS Materials Conveyed by a Wireless Device.

There are a number of views about evaluation of pedagogical software (Stern et al., 2005). We have adopted the outcome evaluation method or summative evaluation (Reeves, et al, 2003). We focused on the extent to which the user has attained the learning objectives as a measurement of learning effectiveness. We also examined the process of how learning materials are used in correlation to whether they achieve an effect. Process evaluation gave us a more complete picture of the learning process, and informed the design of subsequent software.

We report the data from observations of 100 undergraduate students engaged in studying web programming by means of multimedia vignettes delivered via wireless devices in supplement to the textual content available on the LMS.

2.2 Survey Results

In –situ observations and consequent summative evaluation of achieving learning outcomes have been carried out on students with no previous knowledge of the topic described in the learning unit.

Observations of students using mobile devices for asynchronous study have uncovered several factors hindering use of mobile devices for viewing and accessing learning content, such as:

- Small screens on mobile devices,
- Fewer controls/buttons than on a wired computer,
- Learning curve for usability of search and other functionality,
- Availability of connection – 55% of respondents identified public transport (mostly buses) as one of the possible places for m-learning. Some students commented that changing from a bus to subway may prevent effective learning continuum,
- Lack of information describing content of learning material vignettes, especially multimedia.

3 TECHNOLOGY INFRASTRUCTURE

To interface effectively with wireless environment, learning content must be indexed with learning object metadata, which is used to support search and retrieval of learning objects. With IMS-compliant learning object metadata available in XML format, it is a relatively straightforward process to apply the selection and inclusion process to content rich didactic resources. The J2ME platform's MIDP (Ortiz, 2004) reads in the metadata relating to available learning objects into the system as a series of XML documents. Relevant learning object descriptors are made available for navigation and retrieval on the client device. The server has the actual published services that are available to the client. Metadata relating to the critical learning objects is searched for and learning object resources are transported from the LMS server to the mobile learner (see fig. 3).

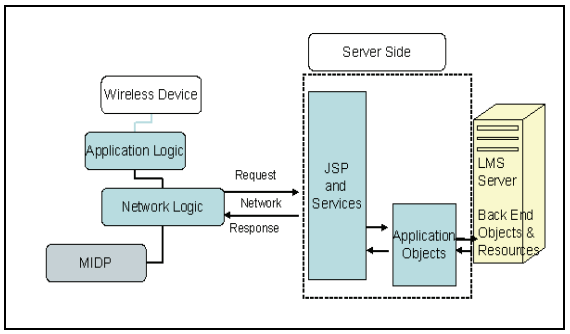

Figure 3: System Architecture.

The capabilities of viewing web multimedia in wireless setting are hindered by the restraints such as reduced output screen, transmission speed and file size. Though multimedia, and video in particular, can be a powerful teaching tool in e-learning providing video for wireless faces many challenges (Sharples, et al, 2002). Because of the reduction in viewing size to accommodate quality and device limitations, smaller objects on a reduced screen become indiscernible. This is of particular concern for a course, which depends on the ability to view items as small as mouse pointers, text, icons, and other computer outputs.

4 UBIQUITOUS ACCESS TO LEARNING RESOURCES

Well-structured LMS content with clear navigation between objects can be linked together with a wireless interface. Wireless technology can enhance teaching possibilities, as well as provide learners with a way to obtain knowledge any time they are willing and able. The benefits of wireless access to learning materials are numerous:

- Students are aware that they have access to the critical VLE content, and only content rich elements are provided for asynchronous learning. This means that they will spend less time finding necessary information than on the wired LMS.
- Multimedia content is technologically adapted for limited resources on mobile devices. Video screen fragmentation and magnification of visual content alleviate usability issues.
- New technologies generate interest in learning. Learners use wireless devices anytime anywhere and well-planned learning can really work in ubiquitous settings.

It should be possible to use an m-learning system without reading a user manual, and the experience of studying with the help of such devices should be interesting and engaging.

5 DISCUSSION

We believe that a popular adoption of m-learning as a complimenting element of e-learning depends on a number of success factors. M-learning should meet the difficult test of user acceptance and must be designed with certain constraints in mind:

- Provide a good initial experience and learn quickly for novel users. The first use should offer a straightforward, acceptable way of locating the necessary learning materials. The benefits of using mobile learning should be apparent to the learner. Content of learning objects should be clearly described and presented to the user in a clear order.

- Support multiple modes of information access. Although we have found that students navigate through the learning objects using section headings, content should be searchable for keywords.

- Avoid brittleness (Beale, 2004). A single action, such as selecting something accidentally or skipping over a content segment or a topic should not have a drastic and unrecoverable effect on learning continuum.

Finally, whether or not availability of mobile access to didactic resources can achieve its potential and facilitate students' learning effectively depends on how it is used by teachers and learners. Therefore, it is important to provide appropriate support to learners through help functions of the device and to immerse these technologies with everyday teaching and learning activities.

6 CONCLUSION

The aim of this project was to avoid re-development of the existing online teaching resources and use them for wireless learning. We focused on general methods for adaptation of online didactic materials portable across various LMS software platforms for cost effective integration and re-use of online learning materials for wireless access. A literal translation from e-learning to m-learning is inadequate. Merely squeezing data onto small screens of wireless devices detracts from user experience. By adapting content rich materials from wired LMS, pedagogical resources can be effectively delivered for asynchronous learning on wireless devices. The instructor and students can use online and wireless educational technologies to make the most from the synergy of wired LMS and the convenience of wireless ubiquity. We consider the services and possibilities that mobile devices offer as promising especially when it comes to the development of new learning methods and pedagogical techniques, which use wireless devices as an effective platform. Compared to face-to-face or blended learning, m-learning is still viewed as innovative by academic practitioners and students. The paper has addressed some practical guidelines and theory-informed design architecture for effective implementation of m-learning for practical didactic use.

REFERENCES

Sun Microsystems, 2003. *E-Learning Application Infrastructure*. (white paper).

Maise, E., 2001. *The Real Truth about e-Learning Future*, IT Training.

Stern, L., Markham, S. , Hanewald, R. , 2005. *You Can Lead a Horse to Water: How Students Really Use Pedagogical Software*, ITiCSE'05, Portugal.

Sharples, M., Corlett, D., Westmancott, O., 2002. *The Design*
and Implementation of a Mobile Learning Resource, Personal and Ubiquitious Computing, Springer London, Vol 6, No. 3, pp 220-234.

Ortiz, C.E, 2004. *Introduction to J2ME Web Services*, available at http://developers.sun.com/techtopics/mobility/apis/articles/wsa/index.html .

Azevedo, R., 2005. *Using Hypermedia as a Metacognitive Tool for Enhancing Student Learning? The Role of Self-Regulated Learning*, Educational Psycologist No. 40, pp 199-209.

Beale, R., Lonsdale, P., 2004. *Mobile Context Aware Systems: The Intelligence to Support Tasks and Effectively Utilize Resources*, Lecture Notes in Computer Science, Vol.3160, pp 240-251.

Liu, T.C., H.Y. Wamg, J.K. Liang, T.W. Chan, H. W. Ko, 2003. *Wireless and Mobile Technologies to Enhance Teaching and Learnin*g, Journal of Computer Assistend Learning, Vol. 19 pp 371.

Reeves, T. C. , Hedberg, J.G., 2003. *Interactive Systems Evaluations*. Educational Technology Publications, Englewood Cliffs, New Jersey. The publishing company. London, 2nd edition.