mLearn 2011

10th World Conference on Mobile and Contextual Learning

18–21 October 2011 · Beijing, China
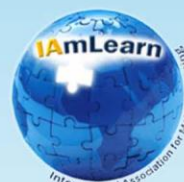
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International Association for Mobile Learning

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10th World Conference on Mobile and Contextual Learning

mLearn2011 CONFERENCE PROCEEDINGS

mLearn2011

18-21 October, 2011

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Preface

This Conference Proceedings volume documents the presentations made at mLearn Beijing 2011. mLearn was the first conference on Mobile Learning and is widely recognised as the premiere international conference on learning with mobile technologies and learning across contexts. This year, it is with immense pleasure that we welcomed participants from more than 31 countries representing all continents, which has made the conference truly international in scope. Participants from all over the world came together at mLearn Beijing, shared their knowledge, experience and research in the field of mobile learning, and further created a dialogue for knowledge sharing and transfer after the conference.

The conference featured keynote talks, symposia/workshops, plenary sessions, parallel presentations, poster sessions, a practitioners' stream and product/service demonstrations. Three keynote speeches covered the different areas of the conference: Mike Sharples (The Open University) talked on Innovation in mobile learning: an international perspective, Chee-Kit Looi (Nanyang Technological University) on Sustainable seamless learning: What have we learned and where are we going?, and Kinshuk (Athabasca University) on the 5R adaptation framework for location-based mobile learning systems. Pre-conference workshops gave hands-on tutorials on how to effectively facilitate different types of learning: e-learning, m-learning, and u-learning. 11 parallel sessions for 42 long papers and 3 parallel sessions for 11 short papers formed the heart of the conference and provided ample opportunity for discussion. In addition, there were 22 non-academic papers from practitioners reporting on ongoing practice of mobile technology in various educational settings. Industrial showcases and poster presentations were distributed across the days of the conference to widen access to these sessions.

Of the total number of paper submissions, 80% were accepted to be included in this proceedings volume. These papers, produced after a highly selective review process, represent the state of the art in mobile and contextual learning. The papers covered the full range of the conference topics, i.e. mobile learning across formal and informal settings, ubiquitous and ambient learning and technology, assessment for learning with mobile devices, and challenges for mobile learning in developing countries.

Credit for the quality of the Conference Proceedings goes first and foremost to the authors. They contributed a great deal of effort and creativity to produce this work, and I am very thankful that they chose mLearn as the place to present it. Credit also goes to the 29 Programme Committee members, who donated enormous blocks of time from busy schedules to carefully read and evaluate the submissions.

Prof. Shengquan Yu

Organisations

ORGANISER

Beijing Normal University

Beijing Normal University, a key university under the guidance of the Ministry of Education, is a renowned institution of higher learning, emphasising teacher education and basic learning in both arts and sciences.

CO-ORGANISER

IAmLearn

IAMLearn is the International Association for Mobile Learning. It is a membership organisation to promote excellence in research, development and application of mobile and contextual learning. It organises the annual mLearn international conference series and manages the website to collate and disseminate information about new projects, emerging technologies, and teaching resources.

SUPPORTING ORGANISATIONS

Faculty of Education, Beijing Normal University	School of Educational Technology, Beijing Normal University	Epic, the award-winning bespoke e-learning company

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PART I: KeyNote

Sustainable Seamless Learning: What have we learned and where are we going?

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ABSTRACT

Our main research focus into the bridging of formal and informal learning has been centred on the notion of seamless learning where learning is distributed across different learning processes (emergent or planned), learning spaces (in or out of class), time, personalized and social learning, and multiple device types. In this talk, we conduct a macro review of the state of our research in seamless learning.

As a backdrop, our contributions to seamless learning are situated within the paradigm of design-based research and implementation. We worked with a primary school in Singapore to study how 9-year-old students leveraged on mobile technology for seamless learning. The research was conducted across various grade levels and subjects (science, mathematics, Chinese language), over longitudinal time scales of between one to three years. Our intervention comprised transforming the science curriculum to harness the affordances of 1:1 mobile technology for inquiry learning. In the spirit of seamless learning, we also fostered the continuous, pervasive, and longitudinal use of mobile technologies for learning anytime and anywhere beyond the confines of classroom. To study such informal learning experiences, we further selected a few students for intensive shadowing to understand their learning patterns in informal environments such as home and the local science centre. We contend that by incorporating the temporal and spatial aspects, we are not only looking at the episodic learning events that happened in our participants' life but their learning trajectory over time through multi-site ethnographies as well.

This work has given us a unique opportunity to interweave a fabric of students' seamless learning experiences enabled by 1:1mobile devices and to share the lessons we have learned in this research. With regard to methodology, we adopted interventionist methods for formal learning, and ethnographic methods for studying informal learning. We will share how the work has informed theory and design principles for seamless learning. Concerning research directions, this work has inspired and led to scaling up of the seamless learning designs and curricula, and to dialogues with the Singapore Ministry of Education on policy and practices for 1:1 computing. To rise above, we posit a participatory research agenda where we believe the concerted effort from the international research community can collectively advance both the fundamental understanding and the applied use of seamless learning.
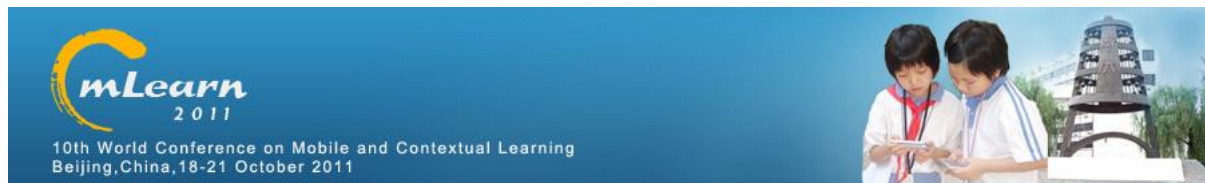
Innovation in mobile learning: an international perspective

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ABSTRACT

'Mobile learning' is a term that varies with context and culture. Related concepts include '1 to1 learning', 'pervasive learning', 'ambient learning' and 'ubiquitous learning'. Each of these can have some combination of technological, educational, or socio-cultural orientation (e.g. learning in a mobile world). This is a strength not a weakness of the field, showing its interdisciplinary and trans-national scope.

Thus, mobile learning research in Europe, arising from the MOBIlearn and m-Learning projects has an emphasis on the mobility of the learner and connecting learning across contexts. In the United States, a predominant focus is on effective delivery of instructional content and applications on portable devices such as smartphones and tablet computers. A related perspective from Asia associated with the G1:1 network, embraces 1 to 1 learning in classrooms with each child equipped with a personal wireless device. Distance learning institutions see the opportunity to support students with personalised toolkits for anytime anywhere learning. Another perspective embraces 'mobile technology for development', where mobilised services including SMS and smartphone web access can enable new forms of learning for basic skills education, professional enhancement, and knowledge sharing.

In my presentation I shall offer an international perspective on the current state and future prospects for mobile learning, in a world of globalised education, online tutoring, open educational resources, and personalised learning services. I shall illustrate this with some examples of where personal meets global, through open inquiry learning.

Research Issues and Applications of Mobile and Ubiquitous Learning

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ABSTRACT

The advance of wireless communication, sensing and mobile technologies has provided unprecedented opportunities to implement new learning strategies by integrating real-world learning environments and the resources of the digital world. With the help of these new technologies, individual students are able to learn in real situations with support or instructions from the computer system by using a mobile device to access the digital content via wireless communications. In such a learning environment, the learning system is able to detect the learning behaviors of the students in the real world with the help of the sensing technology. Such a new technology-enhanced learning model enables learning systems to provide learning suggestions to students when they encounter problems in the real world. In this invited talk, several applications of mobile and ubiquitous learning are presented; moreover, several issues concerning this innovative approach, including the development of Mindtools and learning systems, the design of learning activities, and the investigation of students' learning performance, are reported as well.
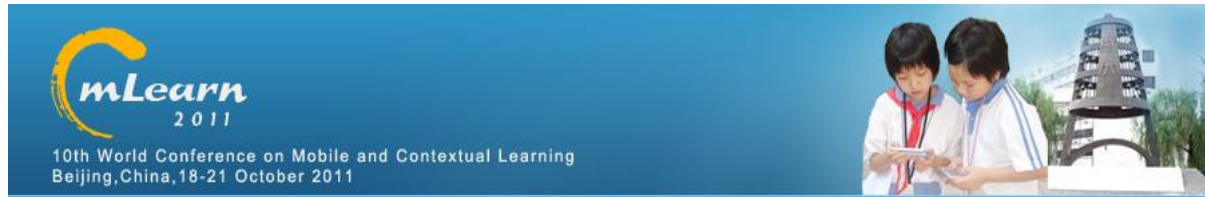
The 5R Adaptation Framework for Location-Based Mobile Learning Systems

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ABSTRACT

Utilizing the location-awareness of mobile devices in developing innovative mobile application system has attracted much attention of academic researchers and commercial application developers. Location-based mobile learning systems have taken mobile learning one step further into the realm of ubiquitous learning by taking advantage of the mobile devices to enhance learner's interaction with their current learning context. This talk will discuss the 5R adaptation framework that has been designed to take into consideration the learner characteristics, the device used by the learner at a particular moment, the current location and past location traces, the timing of learning and the learning contents to suit the current learning goals of the learner. The implications of such contextual learning scenarios will be discussed in the context of authentic learning, that has potential to seamlessly integrate the real physical objects with vast virtual information available online. The talk will conclude with demonstration of applications developed as proof of concept.

PART II: SESSION PAPERS

TOPIC 1: mobile learning across formal and informal settings

Long Papers
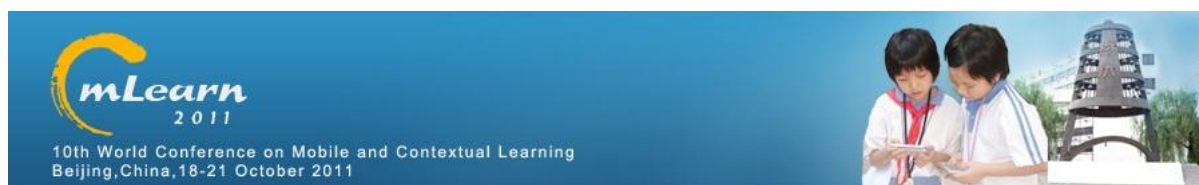
Family-centred learning for Eastern European migrants using a mobile English language application

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ABSTCT

This paper presents a fourteen-week project that explored the potential of mobile phone-based English language learning as a family-centred learning tool for Eastern European migrant families who had recently arrived in the UK. An interactive English language learning application was provided on Nokia mobile phones to a group of families to support their language learning. Participants experienced increased confidence levels across English language skills, and particularly felt more confident in their writing abilities as a result of their participation in the project. Participants were also more confident about taking part in a range of community-based activities, and felt significantly more confident about communicating with their children's schools. More than 70% of the learners used the resources with their families and range of different ways. This project therefore presents a practical model for supporting migrant families with language learning, and evidence of the patterns of learner use of a mobile learning application.

Author Keywords

Mobile learning, language learning, English language, family learning, mobile technology, migration, integration, migrant communities.

INTRODUCTION

Mobile technologies are increasingly promoted to offer opportunities for 'pedagogical innovation' (Conole et al 2008), assisting individuals to learn, access resources, and to capture, store and manage everyday events any time and anywhere (Sharples, Corlett and Westmancott 2002; Luchini, Quintana and Soloway 2004). This potential is reflected in the rhetoric associated with e- and m- learning policy directives internationally (Conole 2007), and a plethora of projects and studies have seized the opportunity to explore mobile devices' potential as supplementary or alternative learning platforms. With fewer constraints on time and location, mobile learning environments have been identified as offering much educational potential for authentic, context-aware, inquiry-based learning in locations beyond the classroom (Cobcroft et al 2008; Liu 2007; Peng, Chou & Chang 2008), and the connectivity of devices has been seen to present real opportunities for enhancing collaborative learning (Zurita & Nussbaum 2004; Lan et al 2007, 2009).

The educational potential has been explored in a number of contexts to support language learning (Collins 2007; Kukulska-Hulme and Shields 2007). The most frequent uses of mobile technology employ text messaging for vocabulary learning (Andrews, 2003; Levy & Kennedy, 2005; McNicol, 2005; Norbrook & Scott, 2003), and quizzes and surveys (Norbrook & Scott; 2003, Levy & Kennedy, 2005; McNicol, 2005). Mobile-based email has been used to promote vocabulary learning in Japan (Thornton & Houser, 2005). Students have also been encouraged to use mobile phones to access web- based video clips explaining English idioms (ibid). Stockwell (2007) links the use of mobile phones for vocabulary learning to an 'intelligent tutor system'. Learners complete vocabulary activities either via their mobile phone or on a desktop computer. The intelligent tutor system creates a profile of each learner and then delivers activities according to the areas they find most difficult.

However, whilst educators and researchers have begun to evaluate their effectiveness and reflect on the challenges presented by the new medium for traditional models of learning (Selwyn 2003), the extent to which mobile technology can result in substantive changes to educational practice, and the most appropriate models for delivery, remain unclear (Vavuola and Sharples 2008). Pearson (2011) reports on the delivery of an interactive English language learning application on Nokia mobile phones to a group of predominantly Bangladeshi women in the

City of London. The findings suggested great potential for the delivery of language materials on mobile phones to socially isolated minority communities, and indicated the value of mobile language learning as a means to improve confidence in access to public services, employment and education. Notably, participants used the tool extensively for family-centred learning, with mothers employing the technology for both personal use and as a teaching tool for their children. This project seeks to build on and extend this model of family-centred learning for migrant groups with Eastern European migrants.

PROJECT RESOURCES

The English language resources in the mobile phone application were divided into 11 themes, each relating to an aspect of daily life and based upon the English for Speakers of Other Languages (ESOL) Skills for Life curriculum. Each theme was divided into three or four lessons, which included exercises to practise vocabulary, spelling, word associations, speaking and listening, reading and writing, and grammar in context. The exercises employed the interactive features of the phone, such as the keypad and the voice-recording function, and presented audio, images and text to make the material as engaging as possible. Additional features included a 2000-word picture dictionary, vocabulary flashcards, a lesson search function, and exercise scoring to record progress and provide feedback to participants. Up to five different users could use the mobile phone application on the same handset, and their activities could be tracked independently. These features are illustrated in Figure 1.

Figure 1. English Language Resources Home Screen

PROJECT METHODOLOGY

20 participants were provided with phones to use with their family for the duration of the 14-week project. The group's English language teacher prompted use of particular elements of the English language resources, but participants could also work through the materials independently, at times and in locations that were convenient to them. The application recorded when and how the materials had been used, and this information was collected from the phones' memory cards at the end of the project. Questionnaires were conducted with participants at the beginning and end of the project in order to collect feedback. The group's English teacher also conducted an assessment of participant language skills at the beginning and end of the project, in order to establish the extent to which overall progress in English language skills had been made.

PARTICIPANT PROFILE

More than half the 20 participants were from Latvia, 20% were from Lithuania, whilst others were from Armenia, Estonia, Hungary, Russia and the Ukraine. Russian was spoken by three-quarters of participants.16 members of the group had a total of 23 children of school age between them. 43% of these children were aged 0-4 years, 17% were aged 5-10 years, and 40% were aged 11-16 years. 30% of the group worked full-time, 30% were

unemployed, and 25% looked after their home and family. 10% of the group worked part-time. 15% of the group had been to university, 40% had left education after college or sixth form at the age of 18, and 45% had left after completing secondary school at the age of 16.

PROJECT FINDINGS

USE OF THE MOBILE PHONE APPLICATION

Figure 2 shows when, over the course of the day, the participants used the application, and for how long. Although a high proportion of sessions were short in duration (0-15 minutes), some of the participants were using the application for much longer periods of time (up to 115 minutes). Whilst activities on the phones were designed to be short in length (lasting 1-3 minutes each) it is clear that participants made use of the phones for significantly longer periods of time. It is clear that the application was in use throughout the morning, and to a greater extent in the afternoon and evening, with considerable activity until midnight and a limited number of sessions throughout the night.
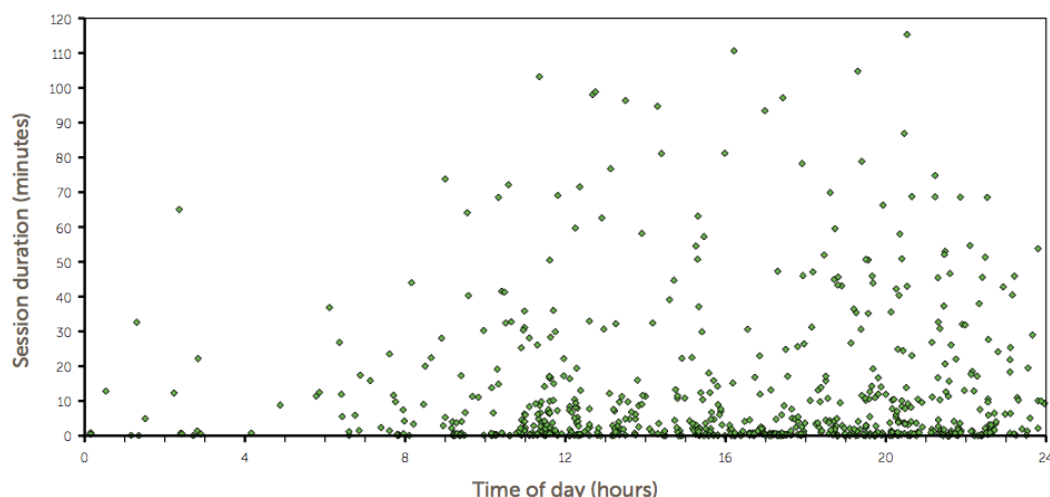
Figure 2. Time and duration of sessions

Figure 3 shows that the phones were predominantly a learning tool used at home, although some use of the phones was also made at work and on public transport. 71% of participants used their phones with family members, and 36% used them with their friends. Participant questionnaire responses suggest a range of different uses of the resources in a family context. A series of participant testimonials describing the way in which the phones had been used by themselves and their families are presented in Figure 4.
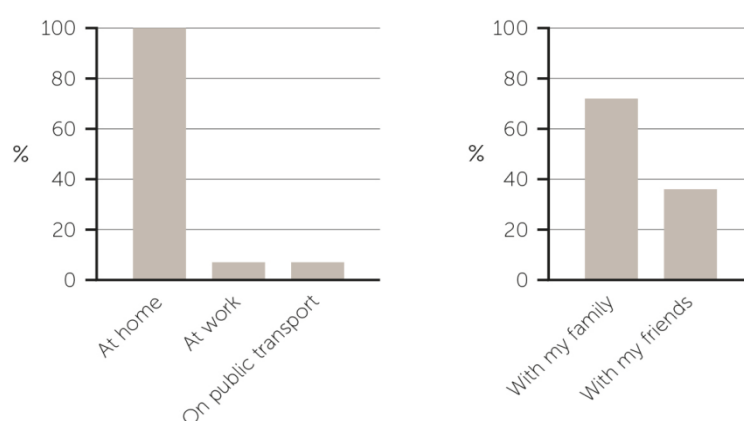
Figure 3. Places of use and collaboration

An Armenian mother and her two-year-old son enjoyed using the phone together to learn English. It became routine that she would take the phone with them when settling him down to bed as a bedtime treat and she would teach him words using the speaking and listening activities. As a result, he has learnt to say many of his first words in English.

A Latvian mother expressed how sad she was to give back the mobile phone because both she and her family had enjoyed using it to learn English and had greatly benefited from it. She rated her own confidence in English before the project at 5 out of 10 but now feels she has reached 8 out of 10. She said that being able to practise speaking and listening in the privacy of her own home has been greatly beneficial in building her confidence.

The mother of a Latvian family described that, of her four children, three had been waiting for places at secondary school. All three of them used the phones to learn English before starting school and this had really helped them to settle in and feel happy when they finally got places. This was especially true of her 14-year-old son, who used the phone to learn some English whilst he was waiting for a school place and this helped him enormously once he began to attend classes. The 'At school' topics, in particular, had helped in building his confidence.

Figure 4. Use of the phones in a family context

Confidence in English language skills

Figure 5 compares participant confidence levels in different English language skills at the outset and close of the 14-week project. Significant increases in confidence are observed across the language skills In particular, the percentage of participants feeling very confident in their writing abilities increased from 16% to 50% over the course of the project. Whilst these increases in confidence could be attributable to a number of factors, these results suggest that the use of the phone application has made a positive contribution to confidence levels in English language skills.
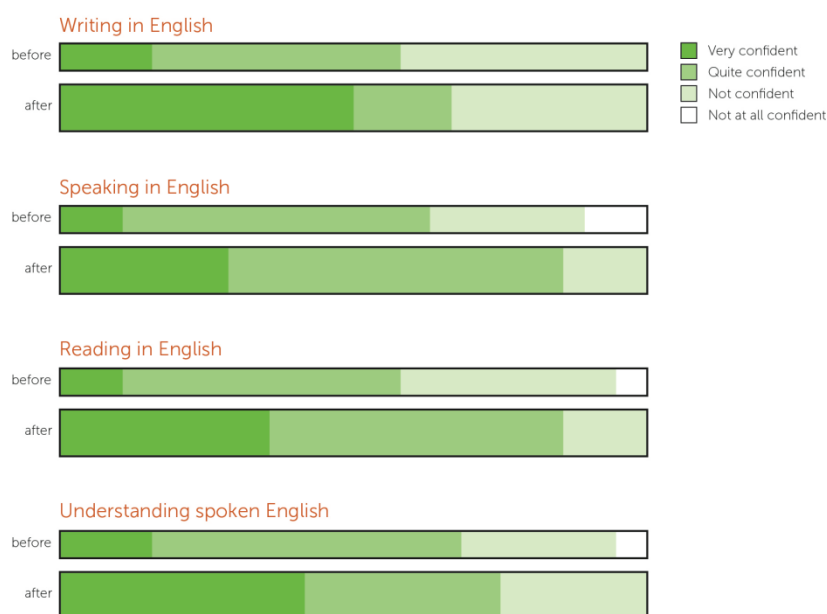
Figure 5. Confidence in English language skills

The English language skills of the participants were assessed according to the 'Kent Steps' Assessment of English as an Additional Language (EAL) – based on the standard QCA/NASSEA EAL Assessment System – at the beginning and end of the project. Figure 6 shows that the average step levels of the group for Understanding, Speaking and Reading increased from between 0 and 1 to between 2 and 3 over the course of the project. This progress cannot be directly attributed to the use of the mobile phone resources, but it does suggest that the group's language skills improved significantly during this time.
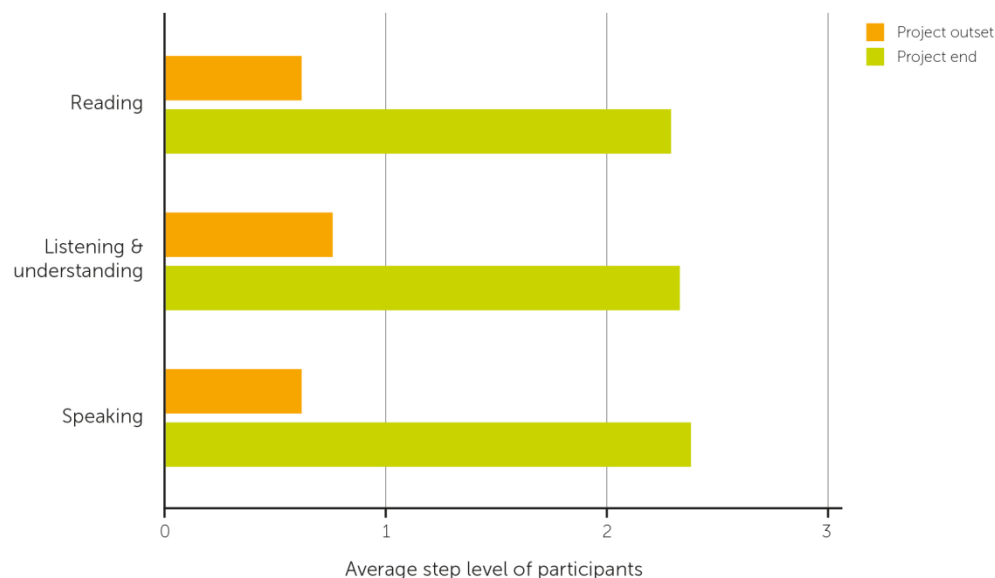
Figure 6. Tutor evaluations of progress in English language

CONFIDENCE TO PARTICIPATE IN COMMUNITY ACTIVITIES

Figure 7 compares participant confidence levels in undertaking different activities within their community at the outset and close of the 14-week project. Participant confidence increases for all the activities. In particular, the percentage of participants feeling very confident about communicating with their children's schools increased from 19% to 30% over the course of the project.
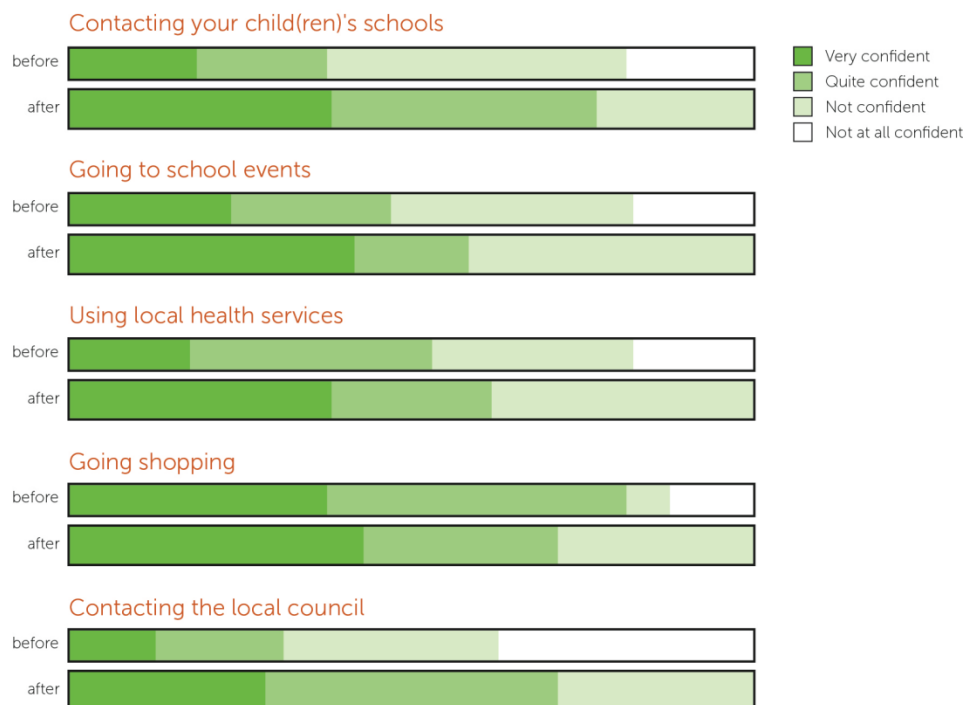
Figure 7. Confidence levels in community activities

CONCLUSIONS

A number of conclusions may be drawn from the project findings. Firstly, participants used the English language mobile phone application throughout the day and night. Participants mainly used the resources in their homes, and

a large proportion used the resources with their families and range of different ways. Participants experienced increased confidence levels across English language skills, and particularly felt more confident in their writing abilities, as a result of their participation in the project. Finally, participants were more confident about taking part in a range of community-based activities as a result of their participation in the project, and felt significantly more confident about communicating with their children's schools.

LIMITATIONS AND FURTHER WORK

It is important to take the conclusions of this project in the context of the circumstances under which it was conducted. The sample size was relatively small, and it was not possible to collect questionnaire data from each member of the family who had used the phone, or reliably establish which family member had covered which elements of the resources. These limitations reflect some of the challenges of conducting research in real-world educational contexts, and the particular challenges associated with evaluating the use of a personal device. It is also appreciated that questionnaire data provide learner opinions or statements of intent rather than longer-term, tangible outcomes.

However, the findings do align with conclusions of Pearson (2011) that the use of mobile technology has potential for delivering appropriate educational material – specifically English language learning resources – to socially isolated minority communities. Participant testimonials and questionnaire responses suggest that the mobile phone application was used successfully as a learning tool within the family unit, and this presents an alternative model for supporting language learning (or, potentially, other types of learning) to socially isolated communities, or groups who cannot easily access other forms of educational delivery. Further work could usefully seek to gain a greater understanding of the nature of the learning takes place within families, and the most appropriate pedagogical principles for resource design and delivery in the context. It is not possible to generalize these findings across cultures and communities, and it would therefore be of value to add to this evidence by running similar projects within a range of different communities, and a range of socio-economic circumstances.
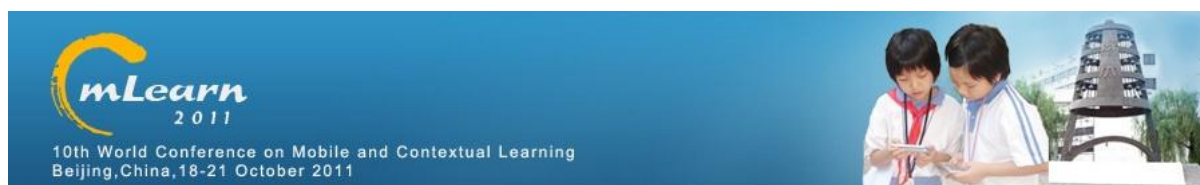
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ACKNOWLEDGEMENTS

Facilitating EFL writing of Elementary School Students in Familiar Situated Contexts with Mobile Devices

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ABSTRACT

This research proposed a situational learning system to help elementary school students practice and improve their English as a Foreign Language (EFL) writing skills. Students carried out assigned writing tasks using the support of mobile devices in situations deemed to be familiar to the students. The study recruited 59 sixth-grade students of EFL elementary school. One class of 28 students was employed as the experiment group and the other class of 31 students was employed as control group. The students of experiment group carry mobile devices to conduct EFL writing in specific and familiar subject environments and stimulated by real context; our proposed system also provided English scaffolding like vocabularies, phrases and sentence patterns for writing tasks. After experiment, the results showed that there is significant difference in learning achievement between two groups. Furthermore, students in the experimental group perceived the designed activities were playful and they were interested in situated learning. In the interview, we also found the activities in familiar context inspired the students to make more sentences and describe the target object clearly and thoroughly with the help of our proposed English scaffoldings.

Author Keywords

Situated learning, Familiar context, Mobile learning

INTRODUCTION

Currently, multinational interaction is becoming increasingly frequent. English is one of the world's primary languages; the default language of activities such as international conferences is English. Guilherme (2007) pointed out that the ability of English language is a crucial factor for international competitiveness. Nunan (2003) showed that countries in the Asia-Pacific region, such as Singapore, South Korea, Japan, Malaysia and Taiwan, emphasized the education of English language very much and the governments planed for enhancing the English proficiency.

In recent years, the ministry of education in Taiwan actively sets up environments of English learning in situations such as the English Village. It is to improve English skills for elementary school students, especially to enhance the skills of English communication including listening and speaking. However, it is not enough since language achievements are correlated with listening, speaking, reading, and writing abilities. In addition, researchers revealed that elementary school students were suitable for learning second language (Snow, 1998; Butler & Hakuta, 2008) and language achievements depend on the well and balanced development of listening, speaking, reading, and writing abilities (Lerstrom, 1990). In order to balance learning goals in English and connect with the English curriculum between elementary schools and junior high schools, grade 5th or 6th students needed to acquire more vocabularies and make sentences (Chuang, 2006). Therefore, enhancing basic writing skills for elementary school students becomes very important since it is a good foundation for students to learn the writing in English.

Research showed that learning in contexts can promote students' motivation (Dörnyei, 2003) and the rich visual resources will help students to write (Vincent, 2001). Another research pointed out that learning language with computers would receive learning achievement effectively (Lam et al., 2001). However, it is not convenient to make sentences with computers in contexts. Lan et al. (2007) showed that mobile devices were convenient for students to conduct a wide range of activities, and particularly for those that involved in contexts. Furthermore, mobile devices could offer rich multimedia information, like pictures, voices, vocabularies, and sentences in situations. That is, this study employed mobile devices to help students for sentences making and basic writing in situations.

However, researchers revealed that there were no significant differences between using mobile phone group and group without mobile devices supported in their literacy attainment (Wood et al., 2011). Kemp and Bushnell (2011) believed that abbreviations, use of mobile phone text-message, were associated with poor literacy skills and the better literacy skills were associated with language accuracy. Regarding children's literacy skills research, although both Finnish and English have phoneme skills at the heart, Finnish text language was closely based on the widespread abbreviated spoken register of the language whereas English text language played in different ways (Plester et al., 2011). In other words, as students practiced sentences making or basic writing in English, it needed something help to scaffold their writing tasks. Therefore, a well-designed system for English basic writing tasks is necessary. This study proposed a writing practice system embedded in mobile devices for students to scaffold their writing.

The purpose of this study is two fold. The first purpose of this study was to propose a writing system and design situated writing activities for "English as a Foreign Language" (EFL) elementary school students to support their writing tasks. The second purpose of this study was to investigate empirically if the proposed system and designed activities for students' writing could lead to more effectiveness. The research questions are as follows: (1) Explore the impact on students' learning achievements while using the proposed system. (2) Analyse the relationship among the proposed system, designed activities, and students' learning achievements. (3) Investigate students' attitude of continue using the proposed system for writing.

LITERATURE REVIEW

English Writing for Beginners
According to Samway (1992), no matter for native language learners, ESL or EFL, they should contact with writing learning in childhood. The research proved that if ESL and EFL children take complete writing practices in earl stage, they can perform systematic/organized progressing. Especially for EFL learners, Curtain and Dahlberg (2004) suggest that although elementary school students are novices, they still need writing opportunities. Writing is a kind of engendering-required capability, writing skills are created by practicing and learning by experiences (Myles, 2002). The research result of National Writing Project(U.S.)(2003) points out that writing skills in early childhood will be engendered by panting, conversation, spelling development and picture story.For developing professional writing skills, schools are strongly recommended not only to give more practices for students, but also to provide rich and diverse writing materials to face the challenges. There, practices in early stage are important.

In this research, the writing activities are designed by situations, through the existed entities in the real world, the writing topics are created with rich visual resources that help students to write. Therefore, the EFL writers' motivation and thinking are stimulated.

Situated Language Learning
There are relationships between real world living-related scenarios and knowledge learning. Students require familiar real context to support learning. When they understand the knowledge hiding in the context, they can apply the knowledge to solving problems in daily life. This kind of circular interrelated relation forms a progression model Learning languages is significantly influenced by situations (Ogata & Yoneo, 2004), and there is an inseparable relationship between languages and culture. Even though learners have no interest on the culture of the language they learn, it still cannot separate the language from its culture (Tang, 1999). However, nowadays knowledge learning activities proceed in real classrooms are only abstract and disconnected with scenarios. In mobile learning, learners can cross the boundary of the classroom to extend their learning, and continuously learning under suitable and motivated situation.

Mobile learning emphasizes the involvedness of learners. The concept of combining mobile learning and context aware learning can reach continuously learning to make students learn in any scenarios that benefit to learning under course and peer learning. Combining the concept of mobile learning and situated learning, learners can reach continuous learning in any scenarios that benefit to learning under course and peer learning.

Most researches on mobile devices are focus on listening and speaking. In this research, the situation is applied in elementary writing. Learners are surrounded by familiar situations in normal life with mobile devices. Describing objects in multiple angles by field observations and giving comments to peers with high level thinking through comparing, communicating, thinking and interactions that stimulate learning motivation.

Meaningful Comment
Peer feedback is defined as an evaluation method that a group of learners with familiar learning experience, background evaluate each other's work (Topping, 1998). Learners according to thinking, comparisons and negotiations give feedback on peer's work. Learners with similar age or learning experience can understand questions and difficulties of learning (Fallows & Chandramohan, 2001). Most scholars take positive attitudes on

peer feedback applied to education. It can inspire the responsibility of learning and stimulate high level thinking to achieve better learning effectiveness (Topping, 1998).

Applying network technologies for peer feedback not only reduce the waste of pens and papers in traditional way, but record the learning path and store every learner's feedback by using the recording capability of computers. Besides, with anonymous mechanism, those non-objective feedbacks can be avoided and increase the reliability and validity. With the use of mobile devices to proceed peer feedback not only take advantages of computer, but achieve the characteristics of ubiquitous computing. In such way, learners can achieve higher performance under the environment with flexibility to move to the learning environment and face to face interaction and communication between peers (Liu & Sadler, 2003).

Stanley (1992) developed a four-step procedure to achieve better peer comment when discussing how to make students become better peer reviewers. These steps were drawn on an inductive analysis of diverse oral communicative behaviors found to facilitate in shaping peer revision in previous training studies and of those examining peer negotiation. (1) Clarifying the writer's intention: Reviewers try to get further explanation of what writers have said or what is not clear to them in the essays. (2) Identifying the problem: Reviewers announce a problematic word, phrase, sentence or cohesive gap. (3) Explaining the nature of problems: Reviewers explain why they think a given term, idea, or organization is unclear or problematic, which should or should not be used in the essay. (4) Making suggestions: Reviewers suggest ways to change the words, content, and organization of essays.

For primary EFL learners, how to proceed an effective peer comment is an interesting issue. Since primary learners have limited capability on vocabularies, sentence types, and writing, how to provide favorable learning scaffold like vocabulary library, sentence type library to help them comment on peer's writing in real scenario is valuable and challengeable. In this research, the situated peer comment activities are designed to let learners carrying mobile devices viewing peer's comment and giving comments. According to the four steps proposed by Stanley, the context helps primary learners to clarify the intension of the author and verify the topic object in real scenario, to identify the true problems by sensory stimulation and give more specific suggestions.

Technology Acceptance Model (TAM)
Technology Acceptance Model (TAM) was developed by Davis based on Theory of Reasoned Action in 1986(Fishbein & Azjen, 1975). In TAM there are two beliefs focused on information system acceptance, which is "perceived usefulness" and "perceived ease of use". Perceived usefulness was defined as "the degree of a user who believes a specific system could increase his/her representation on work", and the point of PU is the expectation when user faces the work. As long as he/she thinks the system might help some way, the attitudes they express will be positive. Perceived ease of use was defined as "the degree of a user who thinks a specific system is easy to manipulate", and the point of PEOU is the functionality of the system. As long as the users think that it is easy when they trying to use the system, their attitudes will be in a positive way, and affect their behavior further. TAM is very important for perceived usefulness and perceived ease of use to predict attitude of users, so we use TAM in our framework and find the items of PU if it will predict the attitude and then to find the correlation of attitude and the actual times of using system.

RESEARCH DESIGN

Research structure
We conduct one quasi-experiment, two classes participated in this study, and one class as experimental group has our proposed system to facilitate their English writing in familiar context, while the other class as control group employs paper-pen based method for their ELF writing. We would like to explore whether there is significant difference between their learning achievements after experiment. Furthermore, this research studies the relationships among users' perceptions and their learning with the research structure derived from TAM and then discusses their reasons behind. The descriptions for the research terms in Figure 1 are as follows:
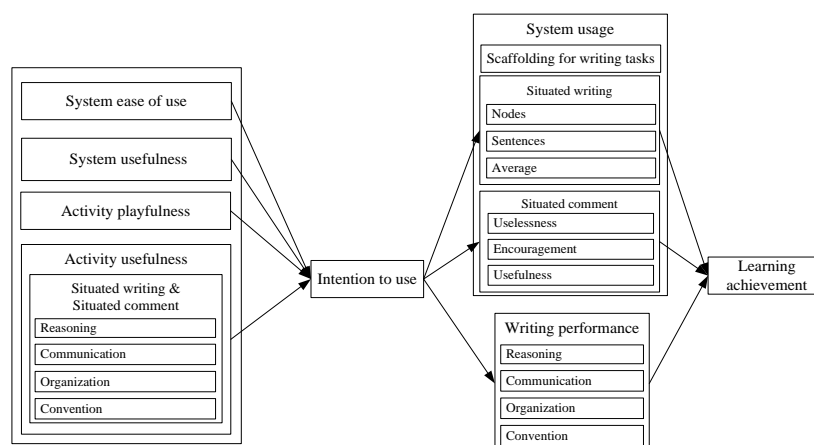
Figure 1. Research structure

According to the definition of Davis (1989), system ease of use is related to the degree of users who perceive that the proposed system is easy to use is estimated by questionnaires in the research, system usefulness is related to the degree of a user who believes our system could increase the performance of English learning in the research, while activity usefulness is defined as the degree of users' perception that our activity could help their English learning. Activity playfulness is derived from the definition of Moon & Kim (2001), which indicates that the users feel interesting and enjoyment when they do the English campus activities in the research. According to the definition of Selim (2003), is related to the intention to use as users' intention to use our proposed system in the research. According to the definition of Ajzen and Fishbein (1980), system usage is related to the system usage as the number of times users actually employ the proposed system during the experiment in the research. The performance of writing represents learners' performance with using English learning system under context. By modifying the evaluating criteria of evaluating the first grade to the eighth grade elementary school in Ontario, Canada, there are four dimensions, including: Reasoning、Communication、Organization and Convention.

Reasoning represents whether the writing is on topic or not. Besides, using supporting details that enhance the description is another criterion to evaluate in this dimension. Therefore, in this research, the two criteria mentioned before (What, Appearance, Position/Taste, Feeling/Function) are applied to be the evaluating indexes. Communication stands for whether the purpose of specific writing is clear and interesting. Besides, if there are different patterns of sentences written in the writing, it also belongs to the scope of this criterion. Therefore, in this research, the amount of adjectives and the amount of sentence patterns are applied to be the evaluating indexes. As for Organization, it stands for whether common ideas mentioned in specific writing are grouped together. Therefore, in this research, if the writer divides his writing into three parts: front, middle, and tail, then he gets credits in this dimension. Further, whether conjunction is used is also another criterion. For convention, it represents whether the grammar, spelling, and punctuation, used in the writing are accurate and appropriate. In this research, the number of errors corresponding to grammar, spelling, and punctuation are applied as evaluating indexes.

Learning achievement represents the learner's outcome during learning. In this research, the learning achievement is the learner's grade of posttest. The posttest is designed by the teacher in elementary school and teaching material. The higher grade students got, the better learning achievement students acquired.

Experimental design

Two classes, totalling 59 sixth-grade elementary school students, who lived in Taiwan, participated in our experiments. One class of 28 students was employed as the experiment group and the other class of 31 students was employed as a control group. For activities design, there are three situated subjects, including Classroom, Meal and Playground. Each situated subject can be divided into two stages. The first stage includes learners proceeding situated writing with mobile devices in situation. The second stage includes learners proceeding comment with mobile devices in situation. Each subject runs for two weeks with three experiments a week, consuming 170 minutes. The whole activities take six weeks. Applying mobile devices to specific subject environments and stimulated by situation and provided scaffolding for writing tasks is the major activities at first and second day of one week. After the day that data of each mobile device is synchronized, learners start to proceed comment with mobile devices according to contents written by peers under specific subject environments. The two stages English writing learning activities are described as follows:

(1) Situated writing: The three situated subjects including Classroom, Meal and Playground are learns' daily places for studying and playing. Students require familiar real context support for learning. After understanding

the knowledge concept subsist in context, they can apply in daily life to solve problems. Learns can decide their own interested writing topic. While learners login into mobile devices, learners can view the map of this subject. First decides a specific topic, the learner can create a writing record by clicking on a corresponding location. Taking pictures on specific writing objects and uploading attachments is the beginning of writing. The corresponding mission explanations, vocabularies, phrases, and sample writings are provided by the mobile devices. Learners can switch scream to look up in real time.

(2) Situated Comment: Before comment, teaching is implemented first to let learners understand how to read peer's writing and how to give comments appropriately in those four dimensions. After synchronize writing contents to each mobile device, learners can view the materials and pictures written by peers by subjects or contents to proceed comment under situation. By following predefined four dimensions: Reasoning, Communication, Organization or Convention.

Research Tool
1. Situated English Writing Learning System

The operation of database in situated English learning system, there are database synchronization and database reconstruction. When the mobile clients connect to the Internet, the students can precede database synchronization or database reconstruction through synchronizing agent.

Before the activities start, the map, instructions of missions, vocabularies, and sample writings will be synchronize to the local databases according to the certain topic. Each learner can browse the topic and map after logging in with proper ID and password. The information helps learners to understand how to complete the mission this week. It provides sample of instructions of the mission, vocabularies, and sample writings.

(1) Situated Writing: The first step is to click "Add Writing" and select corresponding location of the contents in the map. The contents are not restricted in text form. Learners can taking pictures and attached to the writing to increase the richness. After finishing the adding operation, the system will return to the map and there will be a new icon. Learners can open and read the contents by double clicking the icon.

(2) Situated Comment: Before processing peer comment, the serve side database is synchronized to each local database to let learners read peer's writings. After chooseing selected topics or peer's ID, only coressponding contents appear in the map. Learners can read the contents and pictures by double clicking the icon. Also, learners can giving comment and suggestions by clicking "Reply", or clicking "View All Comments" to read all inforation provided by peers.

Figure 3. Situated Writing and situated comment

| **(a). Experimental activities** | **(b). Main screen** | **(c). Scaffolding for writing tasks** | **(d). Double click the nodes to read contents** | **(e). Giving comment and suggestions** |

2. Questionnaire

The questionnaire was designed as a general survey of 70 items, in accordance with the Likert five-point format. It consisted of five subscales including ease of use in the system, usefulness of the system, playfulness in the activities, usefulness of the activities, and intention to use. Moreover, all the items of the questionnaire in the research derived from the questionnaire in our past research (Lu, 2008). Some puzzling or ambiguous items were modified, removed, and arranged following experts' comments in accordance with a proper procedure. Before asking for students to fill with the questionnaire, two elementary school teachers also give us some comments to ensure their students understanding these items of the questionnaire. We then modified the questionnaire again.

The questionnaires were given to 28 students in the experimental class and 28 completed questionnaires were received.

The study used the function, the reliability analysis of the SPSS software package, to analyse the internal reliability of the questionnaire. The results indicate that the reliability of the questionnaire is sufficiently high (total=0.971). Details of reliability for ease of use and usefulness of system were 0.875 and 0858, respectively; Details of reliability for Playfulness of activities, Usefulness of activities and intention to us were 0.920, 0.933 and 0900, respectively.

RESULTS AND DISCUSSION
Experimental results were analysed with SPSS 12.0. This section was divided into five subsections, as presented below.

Comparison of the Experimental Group and the Control Group in Learning Achievement
A pre-test was prepared and given to all participants before the basic writing experiment. According the descriptive statistics of pre-test, that showed the experimental group had higher value [Mean = 52.50] than the control group [Mean = 50.16]. In examining the mean score differences between the experimental and control groups, the t-test procedure indicated no significant differences between the two groups for the pre-test [p value (0.764)>0.05]. The results suggested that students in both groups had similar performance on making sentences in English.

After the experiment, a post-test was given to evaluate whether the experimental group had better performance on making sentences in English than the control group. Results of post-test revealed that the experimental group had higher value [Mean = 74.29] than the control group [Mean = 55.52]. The results of t-test further showed that the experimental group had significantly higher value than the control group [p value (0.001)<0.01]. It implied that students in the experimental group could perform academic achievement better than the control group did.

The results of this study also confirmed that the experimental group facilitated to make sentences for describing objects in contexts than the control group did in classroom. Since the experimental results of this study revealed that the experimental group was significantly better performance, they supported that students used the proposed system in familiar situations having better sentences making and basic writing.

The Situated Writing Activities and Learning Achievement
As Vincent(2001) has pointed out, that students' writing outcomes grew in volume and linguistic complexity when they were offered the opportunity to use the visually rich technology such as visual and animation features of the software. Because of visually rich multimedia and environments, students facilitated to describe diversity of objects by observation in contexts.

Tables 1 listed the descriptive statistics about the amount of nodes, the amount of sentences, average of sentences per nodes, writing performance about reasoning, writing performance about communication, writing performance about organization, writing performance about convention and the sum of writing performance. It showed that students could describe 11.46 objects including 50.68 sentences. That is, students characterized each object using about 4.20 sentences.

	nodes	sentences	average	reasoning	communication	organization	convention	writing performance
Min	3	3	1.00	10.13	11.82	5.54	5.47	34.51
Max	25	147	7.27	24.30	24.70	24.53	24.61	97.79
Sum	321	1419	117.49	452.54	486.18	401.82	430.24	1770.78
Mean	11.46	50.68	4.20	16.16	17.36	14.35	15.37	63.24

Table 1. The descriptive statistics about writing performance

A multiple linear regression was used in the writing performance analysis. As the results show, the value of the Pearson correlation is 0.757***[p<0.001] reasoning, 0.799***[p<0.001] communication, 0.699***[p<0.001] organization, and 0.569**[p<0.01] convention. That is, significant relationships exist among these variables. By the stepwise method of linear regression, choosing the predictor is communication, which can explain 62.4 percent of variety and anticipate 79.9 percent of post-test. The results are displayed in Table 2.

Predictor	R^2	Adj.R^2	F	B	β	t
communication	.638	.624	45.876***	3.104	.799	6.773***

Table 2. The prediction to learning achievement with situated writing activities

According to the result of interview, most students considered that they preferred to make sentences in situations because they just depicted what they looked at. The experimental results revealed that students depicted an object using about 4 sentences. It also confirmed that students could present detail descriptions via observing in contexts. They supported that students used the proposed system in familiar situations having more detail descriptions such as growing volume of vocabularies and sentences. Also it grew linguistic complexity such as using more adjectives, conjunctions and sentence patterns to portray diversity of objects by observation in contexts. Since the experimental results of this study revealed that communication could anticipate learning achievement, they supported that it is helpful for communication to use more adjectives, conjunctions and sentences. In other words, to increase the opportunities about practicing the usage of adjectives, conjunctions and sentence patterns could develop students' learning achievement in English writing.

The Relationship between Situated Comment Activities and Learning Achievement

As claimed by Yeh and Lo (2009), using online annotations as an error correction and corrective feedback would support students' writing tasks in English. The proposed system provided several convenient tools for students to store and query their works and comments.

As the results about the descriptive statistics and Pearson correlation show, the mean of useful comment, encourage comment and Non-related comment are 18.96, 31.71, and 1.14, respectively. The value of the Pearson correlation is 0.778*** [$p<0.001$] usefulness of the comment, 0.038 [$p=.423>0.05$] encouragement of the comment, and -0.190 [$p=.167>0.05$] non-related comment. That is, significant relationships just exist between usefulness of the comment and post-test.

A multiple linear regression was used in this analysis. By the stepwise method of linear regression, choosing the predictor is the usefulness of the comment, which can explain 59.0 percent of variety and anticipate 77.8 percent of post-test. The results are displayed in Table 3.

Predictors	R^2	Adj.R^2	F	B	β	t
Usefulness of comment	.605	.590	39.885***	.745	.778	6.315***

Table 3. The prediction to learning achievement by situated comments

According to the result of interview, most students thought that they were interested in situated writing. Moreover, these students would like to look for the target object which they read and they could check these sentences whether they were correct. It created more opportunities for students to think and practice writing tasks in contexts. The more engaged in writing useful comments in situations, the more promoted the learning achievements in English.

The Relationship between Scaffolding and Learning Achievement

The proposed system also provides some helpful scaffolding such as vocabularies about objects in contexts, related paradigms including adjectives, adverbs, and sentences. These features worked together and held potential for facilitating writing tasks. After analysing the system log of students' using our provided scaffolding for EFL writing, we found students employed the scaffolding a lot and perceived it is useful. The descriptive statistics using scaffolding for each writing task is 91.46(average) and 27.18(std. Deviation). We further analyse Pearson correlation between scaffolding of the proposed system and the post-test, the value of the Pearson correlation of scaffolding for writing tasks is 0.819*** [$p<0.001$]. That is, significant relationships exist between scaffolding for writing tasks and post-test.

In this study, we found a noteworthy case: one student just made a sentence in each theme activity. Rest of the time, he hung around and looked for interesting objects. He then consulted the relevant vocabulary with the proposed system. Finally, he replaced his original sentence by substituting a subject or adjectives rather than to create a new sentence. In the interview, the student explained that he recognized too few words to make sentences so he spent a lot of time to read and memorize new words in situation. The pre-test score of the student is 49 and post-test score is 72. It implied that to memorize vocabularies is good for learning English and the scaffolding of the proposed system satisfied the requirement of students such as this case.

The System, Activities, and Students' Intention

A multiple linear regression was used in this analysis. As the results show, the value of the Pearson correlation is 0.462**[$p<0.01$] ease of use in the system, 0.761***[$p<0.001$] usefulness of the system, 0.855***[$p<0.001$] playfulness in the activities, and 0.612***[$p<0.001$] usefulness of the activities. That is, significant relationships exist among these variables. By the stepwise method of linear regression, choosing the predictor is the playfulness in the activities, which can explain 72.1 percent of variety and anticipate 85.5 percent of the intention to use. The results are displayed in Table 4.

predictor	R^2	Adj.R^2	F	B	β	t
Playfulness in the activities	.732	.721	70.900***	1.071	.855	8.420***

Table 4. The prediction to intention to use with multiple linear regressions

According the result of analysing the questionnaires, most students thought that the designed activities were playful and they were interested in situated learning. Moreover, these activities inspired the students of experimental group to make sentences for describing the target object in contexts and improved their performance in learning English. That is, they intend to participate into the designed activities to continue learning English. Meanwhile, most students thought that the proposed system was useful for them in situated learning. Additionally, most students also thought that the proposed system was easy to use.

CONCLUSION

Writing in situations for elementary school students is a challenging task. This research designed learning activities and proposed a situated writing system for elementary school students to practice the English writing tasks in familiar contexts. By analysing the data of pre-test, post-test, questionnaire, interview, and learning performance in familiar contexts, the results showed that students using the proposed system in familiar situations could have better sentence making and basic writing.

The experimental results were encouraging because the students of the experiment group were found to have significantly better performance than the control group in writing tasks. Moreover, the experimental results supported that students could present detail descriptions via observing in contexts. Since the experimental results of this study revealed that communication could anticipate writing outcomes, they supported that it is helpful for communication to use more adjectives, conjunctions and sentences. Base on aforementioned discussion of the above subsection, to increase the opportunities about practicing the usage of adjectives, conjunctions and sentence patterns could develop students' learning achievement in English writing.

Regarding the usage and perception of the proposed system, the more engaged in writing useful comments in situations, the more promoted the learning achievements in English. Also, the results of the experiment revealed that the scaffolding of the proposed system satisfied the requirement of some students such as memorizing vocabularies in familiar contexts. According to the result of analysing the questionnaires, most students thought that the proposed system and designed activities inspired them to make sentences for describing the target object in contexts and improved their performance in learning English.

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Self-directed English vocabulary learning with a mobile application in everyday context

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ABSTRACT

Vocabulary is the important component of language proficiency. How to help students to enlarge their vocabulary is a challenge for English teachers. This study explores the experiences of undergraduates and graduates students in China to build vocabulary through a mobile application- Remword installed in their mobile phone. Survey and interview data were collected and the following findings are found (a) students are self-directed and well automate in their vocabulary learning with the affordance of this software in their everyday life. (b) Students indicated high readiness to mobile learning. (c) Challenges are indicated to the sustainability of mobile learning.

Author Keywords

English vocabulary, mobile dictionary, everyday, self-directed

INTRODUCTION

A large amount of applications—cell phones, personal digital assistants, and portable digital audio players—has been widely employed in second language learning. Mobile technologies offer numerous practical uses in language learning while it requires thoughtful integration of second language pedagogy.

In this research, we intend to examine how university students use Remword (a digital dictionary installed in mobile phone) to learning English words, and how the design of the application might be improved.

RESEARCH BACKGROUND

In China, having been studying English in the teacher-directed contexts in primary and secondary schools for long time, most university students found it difficult to study English with far less scaffolding from teachers when they enter the university. Each student, however, has been required to take National English Tests such as CET4 and CET 6, which requires students to own certain amount of English vocabularies.   For example, CET 4 and CET 6 require the students grasp 4200 vocabulary and 5500 vocabulary separately. Therefore, enlarging English vocabulary is of great significance in English acquisition, and is a major difficulty college students encountered during their college study. Learning outside of classes becomes necessary and important for them as the teachers are not always available as they were in primary and secondary schools.

According to Pilling-Cormick and Garrison, self-directed or self-regulated learning (SDL) was seen as students "taking primary responsibility and control of their learning process, including setting goals, finding resources, determining strategies, and evaluating outcomes"(Pilling-Cormick and Garrison 2007, page number for directed quotes). No longer the passive recipients of education, learners are seen as a consumer making choices in the learning market (Gremmo and Riley 1995). Particularly in social settings in everyday life, students might use "conscious learning strategies" to direct their own learning (Wenden 1981). University students are adults and primarily responsible for the organization and direction of their own learning. We argued that university students who learn vocabulary out of class are self-regulated as they are articulated motivational with external management practices and internal monitoring processes (Zeidner, Boekaerts et al. 2000). University students may have their own individual goals to learn English and the strategies of memorizing English words vary greatly.   Their methods of memorizing vocabulary might be self-paced or calendar-based and they prefer to remember them at the best of their time and space. Traditionally some students may carry their self-made cards. They have to spend time on making cards, and the number of cards and the presentation of words is very limited

(for example, no audio or visual). The emergence of mobile technology brings convenience to users with high mobility and flexibility.

It has been reported that most university students have their own mobile phones. In Japan, for instance, cell phone ownership has been reported to be nearly universal amongst college-aged individuals(Dias 2002; Thornton & Houser 2005). In a recent study of students in higher education in China, among the 62% mobile Internet users, 85.7% universities access mobile Internet with their own phones(CNNIC 2010). Large opportunities are there that universities students could be better supported by autonomy as well as self-assessment by using mobile technology in their vocabulary learning.

Digital dictionary is one of the mobile technologies widely used among students in China. However, most of these dictionaries only include the meaning, translation and a few explanations as traditional dictionaries. Advanced mobile technology such as PDAs, tablet PCs, and cell phones has gradually become considered effective tools for vocabulary learning. Large amounts of vocabulary learning system have been developed and used (Chen and Chung 2008) to help students develop English vocabulary.

Considering large population of university students in China and the ROI for each student using mobile phones to remember English words, free or low-cost of mobile application is the most desirable choice for students to sustain their word memorizing with it. We then choose REMWORD, a popular mobile dictionary as the tool for vocabulary learning specifically in our research. We aim to explore the following research questions:

• What are students' attitudes and perceptions towards using Remword in their vocabulary building?

• What are students' strategies of using Remword to memorize vocabulary?

• What needs to be improved in terms of the design of Remword?

METHODOLOGY

A mixed research approach was used in this study. A pre-use survey and follow-up individual interviews were conducted to get participants' behaviour of memorizing vocabulary before and during using Remword. The study lasted for four weeks with naturalistic use of Remword in their everyday vocabulary learning.

PARTICIPANTS

16 students from different departments (4males, 12females) took the pre-use survey while only 13 of them (3males, 10 females) were able to install the mobile application, i.e., Remword, in their own phones due to the constraints of the phones they used. 10 of them were undergraduate students and 3 of them are postgraduates.

Participant	gender	major	grade	Model of mobile phone	Internet Traffic per month
1	female	Educational technology	Fresher	Nokia e71	50mb
2	female	Educational technology	Fresher	Nokia e63	50mb
3	male	Educational technology	Fresher	NokiaE63	70mb
4	female	Educational technology	Fresher	Nokia5230	100b
5	female	Educational technology	sophomore	Nokia s60v3	90mb
6	male	Educational technology	sophomore	NokiaE63	70mb
7	female	Educational technology	sophomore	Nokia5233	40mb
8	male	Educational	sophomore	Nokia 6120CI	30mb

9	female	Computer Science	Fresher	Nokia6120ci	50mb
		technology			
10	female	Computer Science	Fresher	Nokia5233	50mb
11	female	Educational technology	first-year graduate	Nokia 5230	20mb
12	female	Educational technology	first-year graduate	Nokia 5230	50mb
13	female	Educational technology	first-year graduate	HTC G9	20mb

Table 1: Profiles of the participants

INSTRUMENT

Remword is a free mobile English-Chinese dictionary, which can be installed in diverse mobile phones. The distinguished feature of Remword is that it is not only a dictionary but also has some aids for vocabulary memorizing.

Dural-Code Theory and Ebbinghaus Forgetting Curve are important theories underpinning vocabulary building. Dural-Code Theory suggests that both visual and verbal codes for representing information are used to organize incoming information into knowledge that can be acted upon, stored, and retrieved for subsequent use. Mobile technologies are advancing quickly. Their output became both verbal and visual(Colpaert 2004),which might facilitate memorizing English words. Remword provides text, image and audio to assist word memorizing. Figure 1 is a screenshot of Remword. Different vocabulary database such as CET 4 or 6, IELTS had been built into this dictionary. Users then can choose their own learning goals by choosing the vocabulary database. User could choose any vocabulary database they need. Remword also can remind users to memorize vocabulary periodically.
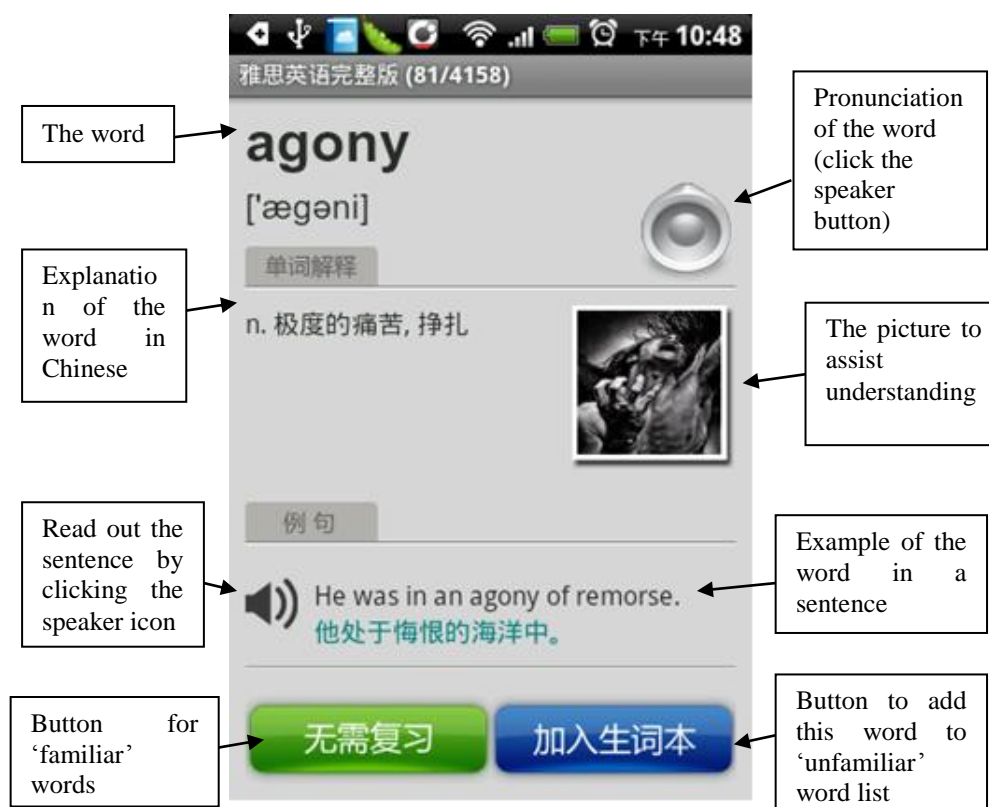
Figure 1: Remword Screenshot

The screen was divided into four main sections. When a word is displayed on the screen, the learner can read the word by his/her self from phonetic symbol or can click the button on the right top of the screen to listen to

the pronunciation of the word. In the second section, Chinese explanation and a picture were given to help learners understand the word. In the third section a sentence was given to provide a context that the word can be used together with a speaker icon optional so that learners can listen to reading of the sentence. And in the last section at the bottom of the screen, two buttons for learners to choose 'familiar' or 'unfamiliar' to construct their own personalized database of "new words".

Ebbinghaus Forgetting Curve illustrates the decline of memory retention in time. It suggests that vocabularies have been remembered could be forgotten. Therefore, Remword has a word review system which automatically records words or terms which were viewed by users and shows them again. When students click 'unfamiliar' button, the word will be collected into the "New Word Book" in this application. Each student has his/her own personalised "New Word Book", which is formed during the process of his/her reading about the English words or terms that were identified as "unfamiliar words". Figure 2 below illustrates a list of the "New Word Book".

Figure 2: Personalized "New Word Book" in REMWORD

In this "New Word Book", "Unfamiliar words" were collected and displayed randomly with the regulation of Forgetting Curve. The active recall of a word is one of the best methods to increase the strength of memory. For near-perfect retention, initially repetitions may need to be made within days, but later they can be made after a long period. Herein the application records the exact time when each word is displayed to the learner and displayed the time of the last recall. The application automatically tracks how many times that a word or phrase been viewed in the "New Word Book" and also displays the tracing by stars of rating. There is also a search engine embedded in this "New Word Book". Learners can enter any search word to find what they remembered before to start their own pace of new words memorizing. Meanwhile the time of each word or phrase students learned the words are also recorded. This mechanism offers a guarantee as far as possible for individual learners to learn vocabulary completely at their own space towards a learning purpose. Put it in another way, this "New Word Book" provides personalised own dictionary to fulfil the needs of self-directed learning.

PROCEDURE

16 participants volunteered to fill a survey of willingness for using mobile phones for vocabulary learning in Chongqing. Students were asked to install Remword with the researchers' help. 13 of them succeeded but 3 students dropped out as Remword was not compatible to their own phones. 12students' phones were symbian phone and one has an android phone. They were asked to feel free to use the REMWORD for their vocabulary memorizing specifically. After one month of the installation, an interview was conducted to know participants' experiences.

ANALYSIS

A questionnaire consists of several open questions. Follow-up interviews were analysed with thematic coding. We utilized Nvivo as the tool for the analysis and have the test of inter-rater reliability among two researchers with the agreement value 0.732 (Cohen's Kappa).

FINDINGS

According to survey and interview, findings are as followed:

Motivation for vocabulary remembering

Although all students admit their primary motivation to word memorizing is to pass CET4 and/or CET6 Exams, five of them articulated their willingness of continuing vocabulary learning because of personal interest in English songs and potential needs in future career. However, they also expressed their doubts and confusions about how to sustain their English learning after the graduation. The awareness of life-long English learning indicates the requirement of methods and tools to support long-term learning any time anywhere. Students only have one or two English lessons each week therefore students need to more self-regulation in their own learning. We found most students have to spend time out-of-class in memorizing English vocabulary and our data indicate that several changes as result of students' using of mobile phones as the tools.

Changes of time

Changes have taken place on the time and duration for vocabulary memorizing since they use the mobile application Remword. By comparing the time they spent on vocabulary memorizing before and during this research, we make a summary of time referred by these participants from the data of survey and interviews.

	When	Without mobile phones	With mobile phones
Self-planned	In class	8	4
	Before English class	1	1
	Between the classes	1	1
	In the morning	3	2
	Before sleeping	1	6
	On jogging	0	1
Unplanned time	Walking	0	2
	Boring	1	5
	Eating	0	1
	Leisure time of evening	0	2
	Once thinking of	0	4
	Listening to the music	0	2

Table2: Number of references of time for remembering vocabulary

We found students had their self-paced or self-scheduled arrangements for memorizing vocabularies. In Table 2 we differentiate the time they mentioned in the survey and interviews for vocabulary learning as "planned" and "unplanned". Traditionally students mainly learnt and remembered vocabularies in class, which they inherited the habit of English learning in high schools. Other than the English classes, they took some time between two classes, self-scheduled some time in the morning and in the evening to memorize English words. Obviously the time had been left out particularly for memorizing vocabulary by different individuals. Put it in another way, they had own plans for vocabulary memorizing. Nevertheless, we found in the "unplanned time", more emergent learning occurred when students have their mobile phones installed with Remword. More learning occurred in 'fragmented' time such as walking, eating, and listening to the music and on thinking of. They just took out their mobile phones and started vocabulary memorizing.

The duration of memorizing English vocabulary with this mobile application each time also varied greatly. Some students removed the scheduled time in the morning about half an hour planned time special for vocabulary memorizing but turned the time into more 'fragmented' periods to memorize words at any free time. Although the time is fragmented, students pointed out that mobile phones provide great convenience of referring to vocabulary instantly and contextually. On the other hand this also partly implies that students have gained more autonomy of time for learning by using mobile phones.

Change of place

Other than the changes of time spent on memorizing vocabulary, choices of places for learning vocabularies also changed. In our research, students were found to conduct increasing vocabulary learning out of traditional learning space. Table 3 below illustrates the places mentioned by our participants in their vocabulary learning.

	Where	Without mobile phones	With mobile phones
Traditional learning space	In the classroom	8	5
	In the dorm	2	6
	At lakeside (quiet places)	1	0
Learning space as emergent	On the way (to the classroom, canteen and dorm)	0	7
	Anywhere when boring	1	4
	Canteen	0	1
	In bed	0	4
	On the bus	0	3
	waiting	0	3

Table3: Number of references of place for remembering vocabulary

Table 3 shows a decrease of references for learning vocabulary in formal settings, i.e., the classroom. More learning is happened in informal settings in everyday life such as ….. . Students reported more learning activities on the move with mobile phones. More diversity of places for memorizing English vocabulary was reported. Students were able to learn vocabulary at any place with their own phones. This expansion of learning space also indicates that students have gained more autonomy for learning vocabulary.

Change of strategies

Among the 13 students in pre-study survey, 8 of them said they wrote down the English words on paper while they were learning the vocabulary. Two of them relied heavily on phonetic symbol of the words, and one of them said he/she preferred memorizing vocabulary in the context of a paragraph or sentence. Two of them liked to associate the word with other phrases or similar words. All of them need to repeat a new word several times in order to remember it and required the recall or review at certain intervals. Two girls used to carry cards daily to make memorizing vocabulary easier.

After these participants have used mobile phones as the tools for memorizing English vocabularies, several changes were found about their learning strategies.

Before students used mobile phone for vocabulary memorizing, most of them preferred writing down the words on remembering them. Using Remword, students described that they only looked at the words on mobile phones again and again and got rid of pen and paper. They didn't have to make cards by themselves and carry the limited number of cards only for learning vocabularies. The big memory of mobile phone supplies enough space for storing English words. They could choose 'familiar' or 'unfamiliar' to differentiate those words as known and unknown. In this way, those 'unfamiliar' words would be appeared more frequently in the mobile application to draw students' attention. Automatically students got personalized paces on memorizing the words step by step.

Instead of reading the English word out when they tell phonetic symbols, students were able to listen to the standard pronunciation provided by the mobile application and follow it. Eight out of 13students in the later interviews agreed that this feature helped them dramatically in pronouncing the words correctly, which enhanced their efficiency of memorizing the words.

As students carry their own phones all the time, increasing chances are there for them to learn vocabularies at their convenience. One example below reveals the great changes that mobile vocabulary application brought to students.

 "Mobile vocabulary learning increases the channels for active learners and promotes the chances for passive learners." (Female, undergraduate)

Students had a good awareness of the strength of mobile technology in vocabulary learning that it offers other accesses to learning vocabulary on the move anytime. But they also realized that to be a successful mobile learner, they need to be independent, active, and purposeful. Students know they should take initiatives to learn vocabulary and direct the learning by themselves.

Readiness for mobile vocabulary learning
According to interview, all participants expressed that they liked the experiences of using their own mobile phones to learn vocabulary and enjoyed very much the convenience and flexibility that mobile phones bring to them for vocabulary building.

"I never spent time on remembering vocabulary before when I entered the university. However I can refer to the vocabulary anytime now as I carry my own mobile phone all the time. I start remembering words and will keep doing afterwards." (Male, undergraduate)

This student stated that he made a dramatic change in vocabulary learning, from a non-vocabulary remembered to a mobile learner of vocabulary because of the use of Remword. Most students didn't like carrying a book all the time for learning but all students in this research admitted Remword enhanced their vocabulary learning. They all agreed that Remword can help them remember more words then before. The convenience of carrying mobile phones was proved to be an advantage for vocabulary learning. Most participants said they felt more at ease to learn vocabulary with mobile phones because they can have full control of learning without taking a heavy book with them. One students pointed out this mobile application improve her motivation to memorize English words as she felt she were doing casual learning like playing a game. Half of the learners stated that they can remember more words each time because now they could make full use of the 'fragmented' time for vocabulary learning.

"I felt less confused for learning English. In the past it's ridiculous and not feasible to hold a book at all time for learning. Now it changes. Mobile phone is one of my favourite belongings and I took it with me all the time. Reading vocabulary from my own mobile phone make me has a sense of playing a mobile game" (Female, Undergraduate)

The girl quite enjoyed her experiences of learning vocabulary on her own mobile phone. For her it seems less stressful to memorize vocabulary on mobile phones than reading the book in the classroom. As students had the self-awareness of memorizing vocabulary, they directed their own learning with more freedom and at their own paces.

The features of Remword participants liked most and felt most effective include:

- Affordable. Remword is free of charge for downloading
- Accessibility. The online and offline settings provide sufficient updates and synchronization. Students can access to mobile Internet for updates as the costs are far lower now (on average ￥10/month for 50Mbytes).
- The function of audio pronunciation enhanced the learning efficiency.
- The use of picture alongside with each word assists vocabulary association and therefore enhances word memorizing.
- The example sentence provides a good context for the user to understand the vocabulary and assist word memorizing.

Feedback to improve the design of the mobile application
Feedback from our participants indicates some improvements might be made to facilitate students' vocabulary learning.

- Needs more relevance between the picture and the word itself.
- Includes the updated and top-rated news in English.
- Includes the ranking for unfamiliarity to new words and display those words in order of unfamiliarity.
- The examples could be more close to everyday life so that students can easily applied what they have learned
- Remword was designed and triggering at CET 4 and CET 6, fitting students' needs at large. Half of the participants suggested an assessment section to be added to Remword to evaluate their own learning outcomes. It indicates an orientation towards independent language learning. Probably a good way to say is: "assessment might be valuable adds-on for the future design of the application, as it will facilitate self-directed learning process. ".

From these responses, it indicates a trend that students have more personalized and self-paced requirement for learning vocabulary. Their learning is getting fairly self-directed and not limited to the CET4 and CET6 tests. They anticipated the real application of English in their everyday life.

Challenges to the sustainability of mobile learning
Although all participants like this mobile application, several challenges exist for individual students to sustain mobile vocabulary learning:

- Students should have their own relatively high-tech mobile phones, especially big memory and quick programme response.
- Students should be well self-motivated and self-disciplined to keep learning on pace.
- Mobile Internet traffic and devices should be affordable for students. Application should be easy to operate.
- Updates of vocabulary and attractive English materials are necessary to sustain students' learning motivation.

CONCLUSIONS AND DISCUSSIONS

Attempts have been made to enhance the efficiency and performance of students' English language learning. In this research we examined the use of Remword as a vocabulary learning tool in a college environment. Students spent their personal time to learn English especially for English word memorizing. They self-scheduled their time and self-initiated to remember vocabulary from time to time. This learning is more self-directed and is not constrained by any other people or by time and space. Students showed diverse strategies to learn vocabulary in our study. All learning was regulated by students themselves and mediated by the mobile learning tool Remword. All students held positive perceptions of confidence and abilities to continue the vocabulary learning with the aids of Remword. In the end of this research all students stated that they would like to continue learning by themselves in their everyday life after this research. As for the sustainability of vocabulary learning, the advantages of flexibility, autonomy and low costs of Internet access all devote to long-term self-directed vocabulary learning.

In our study we only examined 13 students. We have every reason to believe we can scale up as the following reasons: most university students have their own mobile devices and the software is totally free itself. The cost of using mobile Internet in China has been greatly reduced in the past few years and no students felt it as a problem in our study. Students are already aware of the sustainability of English learning after institutional studies and this mobile application at a certain extent articulated their learning in formal and informal environments.

We are delighted this kind of free software would greatly benefit students and hope it's not only limited to students but for all people who would like to carry out life-long learning in the future. And the advancement and development of mobile technology should be able to push forward the life-long learning in more self-paced and self-regulated way in future.

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Studio-Based Learning with Smartphones for Novice Programmers

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ABSTRACT

This paper describes how a studio-based learning pedagogy was adapted from use in the teaching of a freshman introduction to programming course. To reduce cognitive overload a phased approach was used in introducing students to programming concepts and environments. Students began by working in the visual programming environment (Scratch) before progressively moving on to a full programming language (Java) and the final development platform (an Android smartphone). An exploratory case study methodology was used to investigate the effectiveness of combining a studio-based learning pedagogy with the contextualised motivational aspect of application development for smartphones to help overcome the barriers novice programmers face. The findings indicate that the students were able to develop sophisticated applications and appear to have been motivated and engaged by the learning experience.

Author Keywords
Smartphones, contextualised learning;,studio-based learning

INTRODUCTION

A variety of reasons have been put forward as to why learning to program is perceived by many novices as being a very difficult and challenging process (Docherty, Sutton, Brereton, & Kaplan, 2001; Kelleher & Pausch, 2005; Robins, Rountree, & Rountree, 2003). Of relevance to this research is the view of Resnick et al. (2009) that programming is often taught in a context that does not match with the novices' interests or experiences. From a mobile learning perspective it is accepted that at least one context which students increasingly associate with computing technology is that of mobile devices (Kurkovsky, 2009), hence a challenge is to devise a pedagogical approach which exploits the capabilities of, and students' interest in, mobile devices to create an engaging introduction to programming experience for learners.

While a variety of pedagogical approaches are used in teaching programming the dominant one in practice remains lectures and practical labs. One innovative pedagogy which preliminary research indicates could potentially increase student motivation and enjoyment in problem solving is that of Studio-Based Learning (SBL) (Docherty et al., 2001; Hundhausen, Narayanan, & Crosby, 2008; Myneni, Ross, Hendrix, & Narayanan, 2008). SBL places an emphasis on learning activities in which students construct personalised solutions to assigned problems and present their solutions for critical review and discussion (Hundhausen et al., 2008).

This paper investigates the effectiveness of combining a studio-based learning pedagogy with the contextualised motivational aspect of application development for smartphones to create a scaffolded, and engaging, introduction to programming course for novice undergraduate students. The course was devised and delivered by the first author in her place of work and ran for 21 weeks over 2 semesters with 6 contact hours per week.

In order to minimise the cognitive load on the learners a phased approach was followed in the introduction of concepts and tools (Malan & Leitner, 2007). Scratch was used in the initial phase when students were also introduced to studio based learning. Phase two used Java and the Eclipse development environment. In the phase three learners were introduced to developing Java applications for a mobile environment using a mobile phone emulator – for the Android platform in this case. For the final phase pairs of participants were given a smartphone to continue development of their Java programming skills. (For both the emulator and handset phase programmatic scaffolding in the form of Java classes were provided to hide some of the lower level programming details of the smartphone from the participants.)

The research methodology followed was that of an exploratory case study and a comprehensive analysis was carried out of researcher observations, evaluation forms completed by students, video analysis of studio-based

labs, domain expert's views and student interviews. Findings suggest that students were positive toward the experience and were motivated and engaged when solving contextualised problems. The students, as evidenced by the sophisticated applications they developed, overcame many of the barriers associated with learning to program. Student feedback indicated that they saw the relevance of programming apps for smartphones, and that they enjoyed working in groups, presenting and sharing their apps.

TEACHING PROGRAMMING

It is well documented that learning to program is difficult for novices. Reasons put forward include the inherent difficulty in learning problem solving, mastering syntax, understanding how programs are executed, the complexities of programming environments, lack of motivation and programming in contexts which do not match with the novices' interests or experiences (Kelleher & Pausch, 2005; Kurkovsky, 2009b; Resnick et al., 2009; Robins et al., 2003; Winslow, 1996). Furthermore (Forte & Guzdial, 2005) argue that traditional introductory courses often fail to connect programming and computer science concepts with students' diverse interests and backgrounds, thereby failing to motivate many students despite the fact that it is well known that motivated students typically outperform their less motivated peers (Forte & Guzdial, 2005; Jiau, Chen, & Ssu, 2009; Prince & Felder, 2007).

Since the 1960s researchers have been developing programming languages, tools and environments to help students understand programming constructs and reduce the cognitive load on novices. Programming languages used in introductory courses range from Java, perhaps the most widely used languages although it was not designed for teaching, to Python which was designed specifically for educational purposes. Support tools developed to motivate novices range from storytelling tools like Alice (Kelleher & Pausch, 2007) to Scratch, a visual environment that lets novices create their own games, animations and interactive art (Malan & Leitner, 2007; Resnick et al., 2009). Scratch has a "low floor", in that it is easy to get started in it, and "wide walls", in that it allows novices great scope in the variety of animations that they can create, however it has a "low ceiling" in that there is a limit to the complexity of the animations that can be created.

A variety of pedagogical approaches and methodologies have also been employed in the teaching of computer programming concepts to novices but the traditional instruction combination of "chalk & talk" lectures and labs predominates.

Problem based learning (PBL) (Hmelo-Silver, 2004) is an instructional model originally developed in medical schools, in which students are given a complex problem to solve that does not have a single correct answer. The teacher acts as a facilitator and guides the learning process through open-ended questioning thus promoting self-directed learning and providing intrinsic motivation. Successful examples of using PBL in computer science include the teaching of object-oriented programming in the context of game design, (Ryoo, Fonseca, & Janzen, 2008) and learning computer programming logic via PBL (Pereira, Zebende, & Moret, 2010).

In the past decade collaborative methodologies have received attention as an alternative to the traditional model of individuals programming on their own. For example pair-programming involves two people working together on one problem, usually at the same machine (Bryant, Romero, & du Boulay, 2008). PBL is usually, although not necessarily, carried out in groups and while peer review is an integral part of SBL the design of a solution to the set problem can be tackled in an individual or in a collaborative fashion.

Learning Programming & Mobile Devices

Mobile devices have become an integral part of students' everyday lives and Kurkovsky and others argue that their integration into coursework enables students to see the connection between computer science and real-world technology (Kurkovsky, 2009b).

Kurkovsky (2009b) introduced computer science students to mobile game development. A case study was conducted over one semester with students who had some prior programming experience in Java. Students were encouraged to discuss the design of their game, present their work in progress, and brainstorm possible solutions; however they were required to write the program code individually. The findings suggest that mobile devices could be used as tools to stimulate student motivation and interest in computer science and that smartphones offers students more scope for experimentation and engagement (Kurkovsky, 2009a).

Mahmoud and Dyer (2008) used smartphones in an introductory computer programming class in which students were taught programming by developing mobile applications using Java ME. Their results suggest that students felt that they were working on more interesting and exciting assignments and that they were exposed to a new and rapidly advancing area of computing. This improved student motivation and raised their level of excitement and satisfaction with the course. Further research by Mahmoud et al. (2009) observed that high levels of motivation were due to students being able to develop for a real physical device in an authentic context.

Spertus et al. (2010) are investigating the use of Android smartphones for teaching computer science across a number of institutions and preliminary findings suggest that students are motivated to learn programming when they are able to build applications that others might use on their mobile phones.

Studio-Based Learning

SBL is a standard paradigm in the classic design fields such as architecture and art. It places an emphasis on learning activities in which students construct personalised solutions to assigned problems and present their solutions for critical review and discussion (Docherty, Sutton, Brereton, & Kaplan, 2001). SBL requires the learner to exercise Bloom's higher order skills of analysis, synthesis and evaluation and is divided into four key steps (Hundhausen, Agrawal, Fairbrother, & Trevisan, 2010). 1 - Students are given meaningful problems for which there are multiple solutions and for which they have to construct solutions individually or in groups. 2 - Students present their solutions and justifications to the entire class. 3 - Their peers critique the solutions and provide comments. 4 - Students are given the opportunity to respond to o comments and criticisms, and modify their solutions appropriately.

A small number of studies have been carried out in which SBL has been used for teaching computer science and positive results are reported in each case. Barak et al. (2007) describe how students learned Java using wireless notebooks in a studio-based learning environment. Their results indicated that the approach had a positive effect on students' achievements. Myneni et al. (2008) support this view and claim that studio-based learning can potentially increase student enjoyment in problem solving, motivation and interest in computer science. Clinton and Rieber (2010) argue that a studio-based learning environment supports the constructionist ideal of learning via the design and creation of personally meaningful applications. Finally in a formal evaluation comparing studio-based learning with traditional instruction, Hendrix et al. (2010) found that students achieved higher grades and had a better understanding of programming concepts when they followed a studio-based instruction approach.

AN INTRODUCTION TO PROGRAMMING COURSE USING SBL AND SMARTPHONES

Based upon a synthesis of the literature, an overview of which has just been given, an introduction to programming course was designed according to three underlying principles. Firstly, given their motivational potential, smartphones were used as the development platform. Secondly studio based learning was used in combination with a collaborative programming approach to promote collaborative learning and peer review of work in progress. Thirdly to minimise the negative effects of cognitive overload on the desired learning outcomes (Moreno & Mayer, 2007) concepts were introduced in a phased approach and scaffolding (Bruner, 1986; Vygotski & Cole, 1978) was provided in a number of ways.

The breakdown of the four phases was as follows and in each phase students were supported with lectures and detailed notes. The duration of the course was 21 weeks and students had six hours instruction per week.

Phase 1 (3 weeks) introduced students to the Scratch programming environment using a studio-based learning approach. In this phase students had the opportunity to become comfortable with SBL which for all of them a novel way of learning while at the same time they became familiar with key programming concepts without having to master the complexity of a programming language or a sophisticated development environment. Students completed 3 studio-based learning activities with the help of resources from the ScratchEd website[1]. They were required to construct an animation using pre-specified blocks, design an animation in which something surprising happens to a sprite and design a game. Each SBL activity ran over 3 consecutive lab sessions, each two hours long. In lab one, students were required to design a solution individually. In lab two, students worked in groups of four to select and justify the choice of one design from lab 1 and implemented it in Scratch. Students presented their work in progress to their peers for review and comments in lab three. They recorded this feedback and were given the opportunity to respond and modify their design and implementation.

Phase 2 (2 weeks) introduced students to a full blown programming language, in this case Java, and a development environment Eclipse, which is the recommended development environment for Android phones. Students were given two traditional assignments. The first was to implement a simple "Welcome message" using eight pre-specified Java commands. In the second students were given the code for a simple Scratch animation and asked to write something similar using Java in Eclipse. In the second week they were given a studio-based learning activity (again in 3 consecutive 2 two hour lab sessions) and students worked in pairs. The challenge was to design and write a Java class to display a fifteen line message on the console.

Phase 3 (4 weeks) rather than launch straight into developing on a physical phone this phase allowed students to work on an emulator. Students were required to complete an introductory "Hello World" application, and six activities on primitive data types, variable assignments and arithmetic. These activities were designed to introduce the students to the Android mobile development environment and to Android widgets.

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[1] info.scratch.mit.edu/Educatorsweb

Phase 4 (12 weeks) the final and longest phase involved students developing directly on the Android handset. For the first five weeks, students worked individually so as to build up their competence in Java and the Android environment. During the remaining 7 weeks, students completed 2 studio-based learning activities. For both activities, they were required to design, develop and test applications that incorporated user input, simple processing and output for an Android smartphone. The first studio activity was a simple brain training application; the second a music trivia application that incorporated the use of images and audio. Both studio activities took place over 4 (2 hour) lab sessions and students worked in pairs. In lab one students collaborated to design the screen layout of their application and wrote a brief description of how it would work. They then designed the overall program and main methods, each student working on a different section of code. In lab two, they worked as a group to test and debug their code. In preparation for lab three, students installed a copy of each of the other groups' applications on their own phone. They then presented the work in progress to the class for review and comments. As in previous studio labs, they recorded this feedback. They were given the opportunity to respond and modify their design and implementation in lab four.

DATA COLLECTION

An exploratory case study (Creswell, 2008) was used to investigate the effectiveness of combining a studio-based learning pedagogy with the contextualised motivational aspect of application development for smartphones to help overcome the barriers novice programmers face. One of the strengths of a case study method is its ability to explore in detail a case in its "real world" setting and with a limited number of participants (Yin, 2009). The study was bounded by time and a variety of data collection procedures were used (Creswell, 2003). The main focus of the investigation was on the perspective and experience of the participants in the learning process.

The participants were a group of eighteen students taking an introductory programming class taught by the first author at a third level institute. The students were in their first year of an honors degree computing course. Students were of mixed ability. Two of the participants had one year prior programming experience.

Both quantitative and qualitative data collection instruments were employed. These included observational field notes, questionnaires, programming aptitude tests, interviews, and video recordings. The first author was a participant-observer and recorded notes during observations, followed by reflective field notes at the end of each learning activity. Questionnaires were administered in the first week of term and again on completion of the study. This questionnaire was used to assess students' attitudes to learning, to gauge their self-efficacy with regard to using computers and to investigate students' perceptions about teamwork and in-class active learning. Questions were based upon instruments used in other studies. A selection of questions from the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia, & McKeachie, 1991) was used to evaluate students' attitudes to learning and motivation. Students' self-efficacy with regard to using computers was measured using a slightly modified version of a questionnaire used by Tangney et al. (2010) in their research into computer programming outreach workshops aimed at second-level students. Six questions from the questionnaire used by Barak et al. (2007), in their paper on evaluating studio-based learning via wireless notebooks, were used to investigate students' perceptions about teamwork and in-class active learning. A purposeful sample of students with mixed programming abilities, based on their performance in the course, was selected for an informal conversational interview at the end of the final phase of the study. This sampling strategy was employed to enable the first author to document diverse variations and identify common patterns (Creswell, 2007). The studio presentations were video recorded in order to allow the researcher to later review what took place.

Triangulation was attained by combining observations, interviews, and document analysis (Creswell, 2008; Patton, 2002) and five validation strategies were used: peer review, triangulation, clarification of researcher bias, prolonged engagement and persistent observation in the field, and the writing of detailed descriptions (Creswell, 2007).

The final studio was peer reviewed by two domain experts, who were lecturers at the first author's place of work, and both were interviewed after the studio. There was prolonged engagement and persistent observation in the field, which helped provide the researcher with time to make decisions about what was salient to the study, relevant to the purpose of the study, and of interest for focus. All participants were over 18 and signed an informed consent form for data collection and appropriate ethical approval for the study was obtained.

In preparation for analysis, the data was organized into files, and sorted by data type. Audio and video files were reviewed, and selected segments were transcribed and converted to text. The data was coded and these were then combined into broader categories or themes (Creswell, 2007). These are discussed in section 5.

Data Sources Summary

Quantitative data consisted of pre and post questionnaires that explored attitudes to computer programming, and learning motivation (data set 1) and continuous assessment results were used to determine student progress and

learning (data set 2). Qualitative data was gathered using: student evaluation forms (data set 3); researcher observations and video analysis (data set 4); domain expert interviews following studio observation (data set 5); and student post interviews (data set 6) to explore themes and issues that emerged from data set one through data set six.

1. Fourteen students completed both the pre-questionnaire in week one of the study, and the post-questionnaire in week twenty-one. The students were asked to rate their responses on a Likert five-point response scale from strongly agree to strongly disagree.

2. Students completed four continuous assessments during the course of this research. These consisted of two traditional in class theory tests and two studio-based learning activities. The SBL activities were assessed according to three criteria, the extent to which the program met the minimum requirements set in the specification, the degree to which the program adhered to best programming standards and finally the level of sophistication in the program.

3. Students completed six studio-based learning activities: three with Scratch, one with Java in Eclipse, and two developing applications for Android smartphones. Students completed an evaluation form to elicit their perceptions of each studio activity. An analysis of this data set revealed twenty-two codes.

4. The researcher was a participant-observer and recorded notes during the learning activities and wrote reflective field notes at the end of each learning activity. The presentations of students' work in the studio-based labs were recorded using both video and sound recorders. An analysis of this data set revealed twenty-two codes.

5. Two domain experts observed studio six, the final studio, in which students presented their work in progress for peer critique. Students developed an application that incorporated the use of images, audio, user input, simple processing and output for an Android smartphone. Both experts were interviewed after the studio. An analysis of this data set revealed sixteen codes.

6. A total of five students were interviewed following the final studio lab. An analysis of this data set revealed eight codes.

DISCUSSION

The sample size is this study was small and hence the data from the pre and post questionnaires cannot on its own support inferences about the general population. The responses to several questions are however worth noting. There was a positive change in students agreeing/strongly agreeing with the statement "I enjoy interacting with my friends while solving problems" and a negative change in their response to "I prefer being a passive listener during the lesson". These responses would seem to indicate that students felt more comfortable being active in class. A negative shift in the response to the statement "When work is hard I either give up or study only the easy parts" indicates that students were motivated to work on difficult problems in the studio-based environment using smartphones, and were less inclined to "give up" when they found the work to be hard.

The first author has taught programming to first year computer science students for ten years and previous test results from students were available for comparison and it was found that students' performances in the in class tests were consistent with previous years students' performance. However the researcher did observe that the students appeared to have a better understanding of the application of the basic theory that they had learnt, and its relevance in the digital media environment in general, than students taught by traditional methods in previous years. In the studio-based activities students demonstrated a confidence and willingness to experiment with code, and several modified the Java code that was supplied as scaffolding in order to personalise their apps. They developed sophisticated applications that incorporated multimedia elements such as images and sound, and implemented complex and advanced programming concepts such as arrays and event handling.

Research has identified motivation as an important element in helping students overcome the barriers they face while learning to program and one of the strongest themes emerging from the data is that the participants were well motivated.

In the data analysis codes such as "raised expectations", "improve", "air of work", "experiment with the code" and "engagement" were all associated with student motivation. In the studio-based labs, students are given open-ended problems to solve, which gave them scope to arrive at multiple solutions. This appears to have motivated students to experiment with code and be more innovative. The two domain experts who observed part of studio six, noted that the "*lab was quiet, there was an air of work*", "*there seemed to be a lot of people doing a lot of work*", "*the students seemed very motivated, and it gives them early exposure to cutting edge technology*". Further evidence of motivation is that some students wanted to continue to work on their studio projects outside of the labs. For example one interviewee said: "*I am continuing to work on my project at home, I want to modify the first screen, and add a dropdown menu*". One student, when asked to hand back the phone at the end of a lab replied "*no. I'm having fun!*" and continued to test his application on the phone. Another student said it was

"*good fun working and learning to programme on an Android phone*". The researcher also observed an interest on the students' part in the end users experience and the importance of error handling. Students were motivated to test their applications thoroughly and seek to remedy errors and to try to make their applications 'user friendly'.

The students documented the peer feedback that they received during the studio-based presentation and critique labs. They indicated that the feedback helped them identify deficiencies in their solutions, which lead them to consider alternative approaches. Evidence of peer learning also emerged. Students' comments included "*I learned the importance of commenting especially when explaining it to others*", "*I learned that working in a team helps to improve the code as the person I worked with gave me suggestions for shortening the code and tidying it up*", and it "*viewing others work was very intriguing as well*". In the follow-up interviews all students said that they preferred working in groups rather than on their own.

Context has been recognised as an important element in computer science education. This theme emerged in several data sets. There was a general consensus that seeing the Java program working on the phone was better than seeing it work on a computer. Comments such as "*yeah the phone is definitely better than just on the computer*", "*it's a nice way to learn Java, to see it working and see where it can be used, rather than looking at it on the screen*", "*(I) like working with the phones and seeing the result on the Android*". One student with prior programming experience remarked: "*I did programming last year and it is much better (this year), at least you can hold the phone and see exactly what you are doing*". It would appear that the contextualised learning environment appealed to students, and during the course half the students purchased their own Android smartphones so they could install their own apps on their own phones. When queried one such student simply stated "*I wanted to use my own phone in class*".

Students constructed personally meaningful applications. For example one group developed an app on comic book superheroes, another on female pop stars, another on binary numbers and all were keen to share them with their peers. They were also excited to see other students trying out their applications as the following comments show: "*I heard my app a minute ago (and) someone must be playing my app again (now)*", "*I want to use my own phone so I can show people what I have done*". Comments from some of the students illustrate some of the reasons that students found developing for smartphones personally meaningful: "*I like it because it's the way it's going. Android development is the thing now, it's a nice way to learn Java, to see it working and see where it can be used, rather than looking at it on the screen*", and "*(it's great) at the end just to see what you made. It's a bit closer to kind of the apps that you are going to make eventually*".

Students appeared to be interested in designing an application that was "real", and would appeal to "a broad audience". They were also interested in, and wanted to view, the other groups' applications. Comments of interest were "*this lab was good to see how to put up images and music and make the apps more real and see how the other groups did theirs*", "*we chose to use images of comic covers because it seemed like an interesting way to create a memory game which would appeal to a broad audience*", "*we felt that our project was familiar, easy to handle and provided a challenge to our users*", "*we thought it would be a hard but fun app*" and "*(it was a) good learning experience putting all elements learned into practice*". One student wrote that "*I also enjoyed downloading everyone else's programmes on the Android*", this was in preparation for the group presentations and critique lab. In conjunction with presenting their apps in the studio lads, students also were enthusiastic about presenting their apps to their friends outside of the labs. Students made several references to sharing their apps and showing them to others, "*I have shown my friends the apps, because I have my own one (phone)*", "*they just think it's cool. They just see that you can make it (write an android app) yourself*".

The researcher observed that Scratch was a good language with which to introduce students to programming and to studio-based learning. One student commented that they liked the phased approach used, "*(the) structure of course was very good, (i.e., the) lead into programming from Scratch and then the use of Eclipse and the Android phones*". Another student said that using Scratch gave "*a great introduction to the concepts of Java*" and "*I feel more confident now with Java*".

Initially students were disappointed with the delay in installing applications on the emulator, however they quickly got used to this delay. Once the phones were available, the majority commented on the speed of installing an application on the phone and the phones ease of use compared to the emulator. As it appears that this phase was the least productive it will be omitted in the next offering of the course.

A number of unexpected findings were also revealed in this study. The researcher was interested to see students continue to work on resources for their Android applications outside of the course. In a Digital Media Production Techniques module (also taught by the first author to the same cohort) students edited sound files and created images and icons for use in their Android applications. Another example of cross module crossover was one student developing a binary number conversion quiz that could be used by students in Computer Technology Module. The researcher also found that the role of the lecturer was different in the studio labs when compared with traditional teaching environments. In the studio labs, students were inclined to ask more questions, and

demand information on how to implement programming concepts that had not been introduced in lectures. This meant that on several occasions new topics were taught due to students' requests demonstrating the students' motivation to learn. In conjunction with the demand for knowledge, there was also evidence of students' self-directed learning, where students were more inclined to share knowledge and search the Android developers' website and Java API for information.

The cost of providing smartphones for learning and teaching may be seen as limiting. However as seen from the study, smartphones are becoming more ubiquitous, so the cost of providing students with mobile phones may become less of a limitation. At the end of this research fifty percent of the class had purchased their own handsets.

SUMMARY AND FUTURE WORK

This study set out to explore and investigate the effectiveness of combining a studio-based pedagogy with the contextualised and motivational aspects of application development for smartphones to help overcome the barriers novice programmers face.

It follows on from research by Hendrix et al. (2010) that suggests that studio-based learning could potentially increase student motivation in computer science and research by Kurkovsky (2009b) who introduced computer science students to mobile game development as a motivational tool. The findings from this research indicate that studio-based learning is an effective pedagogy when used in conjunction with application development for smartphones. Participants found it to be a positive experience and there appeared to be a general improvement in the students' learning motivation. The domain experts observed that participants seemed more motivated and students could apply what they had learned to their own area of interest.

While the number of participants on the course was modest the findings support the view that developing applications for smartphones leverages off the motivational, authenticity and contextualised affordances of mobile learning. Furthermore the way in which SBL was used and the phased way in which concepts were introduced to the students appear to have contributed to their overall level of engagement with the learning experience and give confidence that the overall approach should be continued in the next academic year.

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Learning Geographical Coordinates and Map Reading with GPS-Aided Geocaching

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ABSTRACT

Past researches have demonstrated that mobile learning is able to bring in positive learning results, including learning achievement and attitude toward technology. However, even encouraged by the government, due to the lack of budgets and exemplified models, most instructors in Taiwan seemed to fall short of applying mobile technologies in their teaching. This study conducted an experiment which designed a GPS-aided geocaching game with a free online resource-Google Maps for high school geography course. The major purpose of the study was to exemplify an affordable geocaching strategy of mobile learning, as well as to examine the effects of GPS-aided geocaching on learning achievements and student's attitude toward the mobile technology. Certain scenic spots in a cultural-abundant site in Taipei City of Taiwan were selected. Students were asked to find those spots. The goal of the activity was to facilitate students gaining more understanding in geographical coordinates, therefore improve the ability in reading geographical maps. Subjects were 142 students from one of the senior high schools in Taipei. These students were from 4 classes, two of which assigned in the experimental group, which performed GPS-aided geocaching with Google Maps, while the other two in the control group, which employed traditional map searching method. The results of the study indicated that: 1. the GPS-aided geocaching group had a better learning achievement; 2. the GPS-aided geocaching group was generally acquired a better attitude toward using technology. In summary, GPS-aided geocaching helped students learn to read maps and recognize the geographical coordinates in a more effective way. The results may encourage educators to develop more innovative instructional strategies with inexpensive mobile technologies.

Author Keywords

Geocaching, mobile learning, Global Positioning System (GPS), attitude toward using GPS

INTRODUCTION

As the continuing advancement of technology, especially the computer technology, the intensive discussions on the issues of "learn to use technology" and "learn with technology" have become more and more emergent in school education. In view of this, the Minister of Education of Taiwan has made clear that "understanding and experiencing the interaction between people and technology, developing independent thinking and problem solving skills, and stimulating students' potential" are some of the major objectives of the Science and Technology domain of Taiwan's high school curriculum. Nevertheless, the development of mobile technology further breaks the limitation of time and space, extends the classroom beyond its physical constrain, and also expands students' learning scopes. Therefore, the use of Geographical Positioning System (GPS) is also listed as a specific objective in the syllabus of high school's geography courseware, students are required to "be able to use of GPS for data collection" (Minister of Education of Taiwan, 2005), and purchasing GPS related software, such as ARCVIEW and digital electronic map, are also recommended. On academic side, recent researches of mobile learning in Taiwan also show that today's mobile technology is helpful in achieving instructional goals. For example, Liu, Peng, Wu, & Lin (2009) designed a series of mobile natural-science learning activities for 4th grade students, the results indicated that the learning activities can enhance students' scientific performances, including both knowledge and understanding levels. They also reported that students' perceptions of these learning activities appear to be positive. Cheng, Hwang, Wu, Shadiev & Xie (2010) helped students learn English on campus using multimedia and GPS supported system-The StudentPartner. Two activities, exploring the campus in English and English presentation were performed with the system. The researchers concluded that the proposed system, when combined with these two activities, is an effective and enjoyable method of learning English.

However, according to interviews with relevant teachers by the researchers of this paper, due to the lack of budget supports and exemplified models, a good portion of teachers in the Science and Technology domain are still stick on traditional classroom instruction. Some teachers even believe that the employing technology to enhance learning is only a castle in the air. They are reluctant to use technology to facilitate solving problems in daily life. Therefore, the objectives mentioned above (i.e.: developing problem-solving abilities and independent thinking skills,) are generally being neglected. The results are that students still mostly rely on memory to acquire descriptive knowledge in the domain of Science and Technology, in exchange for high scores in traditional writing tests. They seldom have chances to either "learn to use technology" or "learn with technology", not to mention the application of mobile technology to break the physical classroom constrain. This is definitely not beneficial for the advancement of technology applications in high schools. Bring in more positive evidences and examples in learning with affordable hardware/software seem to be necessary for encouraging high school teachers to make a major breakthrough in applying contextual sensitive technology to their instructions.

In responding to above critiques, this study attempted to employ a contextual sensitive game-geocaching in high school's geography course with a free online resource-Google Maps, to exhibit a low-cost, mobile-technology supported learning activity, and further examined the effects of such an attempt statistically. The assumption was made that students' map reading ability as well as the attitude toward using GPS devices would be improved after the treatment. Questionnaires and tests were used as instruments for examining the significance the assumption.

The specific objectives of this study are as follows:

1. Analysing the effects of GPS-aided geocaching on understanding of geographical coordinates and reading maps;

2. Examining the influence of GPS-aided geocaching on the attitude towards using GPS mobile devices.

LITERATURE REVIEW

Geocaching

The term "Geocaching" was first proposed by Stum (2000). "Geo" represents the earth. "Caching" is looking for hidden treasures. It is an outdoor treasure hunt recreational activity combining technology and health (Chen, 2003; Yannacio, 2005, Barb, 2007). By playing geocaching game, one may learn about the natural and community environments (Gentry, 2006). This game includes activities of the treasure hider and treasure hunters. The treasure hider usually hides the treasures with a notebook and a pencil in a box, finds a suitable hiding place outdoors, positions the latitude and longitude with GPS, and then transmits the geographical coordinates and tips of the treasure location to a designated geocaching website. This allows treasure hunters to download the geographical coordinates to their own GPS device and use the information to find the treasure. There are some websites which construct interactive electronic maps locating "hidden treasures" around the world, for example, Geocaching - The Official Global GPS Cache Hunt Site (http://www.geocaching.com) is one of the major website which allows registered member to visit numerous hunting sites around the world.

Related studies have shown that the effects of geocaching in learning are significant. Mandy (2006) divided 298 students into 98 groups to conduct a large scale geocaching learning experiment. Students were required to use GPS to find specified hidden treasures. Results showed that teachers were able to achieve teaching objectives more easily and reduce students' fear and exclusion for the use of GPS. It also improved student's spatial concept. Chavez, Schneider & Powell (2004) conducted a GPS geocaching game-based learning used 221 people from the State of Minnesota in the United States. The experimental sites were Anoka, Ramsey & Washington Parks. The results from the survey showed that most people believe, through this activity, one could obtain the experience of using the technological devices and also learn the local natural and cultural history. Those positive results provide the basis for the follow-up study on geocaching.

Implementing Global Positioning System (GPS) in Teaching

Global Positioning System (GPS) is based on the principle of triangulation. GPS receiver measures distance by calculating the transmission time of radio signals. The location of the satellite in space can then be deduced. This is a high orbit and precision positioning observation method. Handheld GPS is designed for personal use. It can have extensive applications in education due to its simple operation, reasonable price and excellent portability (Cheng, 2008).

In recent years, people have accumulated considerably practical experiences in implementing GPS in teaching. For example, Rosenberg (2004) applied GPS in a graphics course, providing students with the school in aerial photographs, group designated latitude and longitude measurements, and then connect the dots, coming up the school plan. Lary (2004) implemented the combination of the GPS and geocaching in the study of subject learning. His study provides some basic information related to the Earth, such as the Earth's diameter, pi, and then use this information to calculate the distance between the latitude and longitude and the circumference of the earth. The information was combined with geocaching to allow students to understand the spatial concept. McNamara (2004)

also pointed out that teachers could apply the combination of GPS and Geocaching to various subjects such as geography, history, sociology, ecology, mathematics, sports, etc.

In Taiwan, although a lack of empirical research evidences in GPS supported learning, the Provisional General Course Outline for High Schools (Minister of Education, 2005) suggested that schools purchase GPS and the related software, such as ARCVIEW and digital electronic map. It also listed the use of GPS as one of the specific objectives included in the syllabus and designed it into a section of geography practical course in high school.

GPS can be applied not only in a single discipline, but also in the integration of teaching, helping students to learn, access to the application of technology products, and everyday live. In the process of learning activities, students have access to discover and solve problems, cooperative learning and independent thinking. Through related actions by learning activities, students have the ability to explore training and teamwork to address the challenges of the current knowledge-economic times.

Mobile Learning

Mikic, Anido, Valero, & Picos (2007) believed that mobile learning has created a new learning environment that enables learners, through action learning aids, teaching materials, teachers and other learners, to learn at anytime and anywhere. Learning content are location-sensitive as learners are free of moving. All learning paths and the contents are recorded accordingly. The advantage of employing mobile technology in learning is not the mobile technology itself, but the unique attributes of the mobile devices that provide an environment which allow apply the innovative learning theory and learning strategies (Su, 2005).

Many local studies on mobile learning simply repeated the concerns of establishing a learning system, then using the mobile devices (such as PDA) with the established system to implement instructional activities (Liang, 2005; Lin, 2006). However, instead of the solely use of PDA to display built-in materials, the application of adequate instructional strategies for mobile learning seemed to be more important. For instance, Schwabe & Göth (2005) designed an instructional system combining mobile learning and mobile game. This instruction used college students as learners. Students were divided into groups to play the game. They obtained information from the website regarding the mission and geographical coordinates of the locations. They then used GPS to complete a task and uploaded the result back to the workstation before they could get the location information of the next mission. The winner was who completed the task first.

In summary, mobile learning tends to be able to improve the learning outcome. Moreover, recent study showed that the computer attitude also positively affected the outcomes of computer-based learning (Ho & Kuo, 2010). If we consider GPS-aided geocaching is a variation of computer-based learning, then we may assume that GPS will also have a positive effect on learner's attitude towards mobile technology. It might further improve the outcome of mobile learning. Therefore, attitude toward GPS has been added to be one of the dependent variables of the study. The instrument used for measuring attitude is adopted and modified from a well-validated computer attitude scale developed by Loyd & Gressard (1984). According to their design, the scale has three subscales: anxiety, liking, and confidence.

RESEARCH METHODS

This study employed GPS-aided geocaching to explore the influence of learning achievement and attitude toward using GPS devices. A quasi-experimental design was employed. The subjects were first-year high school students in Taipei, Taiwan. There were four classes and 37 students in each class. They were divided into the control group and experimental group. After subtracting invalid samples, 71 students in each group were assigned. After classroom lecture on the concepts of geographical coordinates system and map reading, the field experience was performed. The site was selected to be near the school, a place called "Xian-ji Cliff", which is in the Wenshan District of Taipei. The experimental group performed the mobile learning with the implementation of GPS-aided geocaching activities. The control group performed the traditional searching activities by using printed maps. Both experimental and control groups were further divided into subgroups of three for carrying out cooperative learning. Each subgroup in the experimental group was equipped with a GPS, in which Google Map was installed, whereas each subgroup in the control group was equipped with a traditional map. Before the experiment, the teacher secretly placed so-called "treasures" to several locations planned in advance for students to find. During the experiment, students, either in the experimental group or control group, were required to use the map (GPS positioning of Google Maps for the experimental group and traditional map for the control group) to reach designated treasures by the clues hinted by the instructor. Students were also asked to answer several site-related questions. Typical questions such as: Given CUTE, Shih Hsin University, and Police College, which school is closest to the trailhead you are at?

The following table lists the experimental grouping, objectives, strategies and variables. The experimental group was pre-trained with GPS operating instruction with lecture and practice before the field experiment was implemented.

	Control group	Experimental group
Objective	Understand the geographical coordinates system and enhance the ability to read the map	Understand the geographical coordinates system and enhance the ability to read the map
Strategy	Field experience	Field experience
Variables	Visit the designated target treasures near the Xian-ji Cliff. Students find objective and to answer related questions using the printed map	Visit the designated target treasure near the Xian-ji Cliff. Students find objective and to answer related questions using the Google map in combination with GPS.

Table 1. The experimental grouping

Research instruments were a modified computer attitude scale and an achievement test. The modified computer attitude scale was divided into three subcategories: anxiety, liking, and confidence. The achievement test was developed for the purpose of verifying the understanding of the the geographical coordinates system and map reading ability.

These instruments were confirmed by expert validity and internal consistency Cronbach α test, where α values ranged between 0.7 to 0.9.

The following are the outline of the research processes:

1. Before the experiment (after students were taught in the classroom), both groups received a pretest.

2. The experimental group carried out GPS-aided geocaching activities with Google Maps, and the control group carried out the activities of searching using the traditional map.

3. After the experiment, both groups received a post-test. Pre-test and post-test questions were in a parallel form for the two groups.

In this study, we also collected data from an attitudinal survey to obtain information about student background and analyse students' attitude toward GPS mobile devices. The collected data were statistically analysed. The results of the analyses were used for conclusions and recommendations.

RESULTS
The results are discussed in two parts: the effects of GPS-aided geocaching on learning achievement and the effects of GPS-aided geocaching on attitude toward using GPS devices.

The Effects of GPS Geocaching on Learning Achievement
Pre-test results indicated that average score of traditional teaching group (M = 14.23) was higher than the GPS geocaching group (M = 11.76). However, after the experiment, the post-test scores indicated that the average score of GPS geocaching group (M = 16.24) was higher than the traditional teaching group (M = 13.55). By employed an ANCOVA, the significant difference in teaching method was found (F = 39.389, p <.05). It showed that the GPS geocaching method resulted in a better learning performance. Summary of ANCOVA is shown in Table 2.

	SS	df	MS	f	Sig.	Post Hoc
Pre-test	2.689	1	2.689	.422	.517	GPS geocaching > Traditional learning
Teaching methods	251.021	1	251.021	39.389	.000	
Error	885.818	139	6.373			

Table 2. Summary of ANCOVA on overall learning achievement

The study further analysed the treatment effect on individual learning subsets, that is, maps reading subset and the geographical coordinates subset. In the maps reading dimension, different teaching methods resulted in a significant difference on the post-test scores ($M_{geocaching}$ = 7.25, $M_{traditional}$ = 6.11, F = 23.637, p <.05). This means that GPS geocaching helped students gain better performance in maps reading. Summary of ANCOVA is shown in Table 3.

	SS	df	MS	F	Sig.	Post Hoc
Pre-test	.099	1	.099	.055	.815	GPS geocaching > Traditional learning
Teaching methods	42.587	1	42.587	23.637	.000	
Error	250.436	139	1.802			

Table 3. Summary of ANCOVA on achievement of maps reading

In the geographical coordinates subset, significant difference on the post-test scores ($M_{geocaching} = 8.99$, $M_{traditional} = 7.44$, F = 22.438, p <.05) was also found. This means that GPS geocaching also helped students gain better performance in learning geographical coordinates. Summary of ANCOVA is shown in Table 4.

	SS	df	MS	F	Sig.	Post Hoc
Pre-test	.220	1	.220	.061	.806	GPS geocaching > Traditional learning
Teaching methods	81.719	1	81.719	22.438	.000	
Error	506.230	139	3.642			

Table 4. Summary of ANCOVA on achievement of geographical coordinates

The Effects of GPS Geocaching on the Attitude toward Using GPS Devices

The average score of attitude toward using GPS devices for geocaching group was higher (M = 60.85) than traditional group (M = 55.48). Significant difference was found in independent t test. (t = 3.03, p <.05). For the three subcategories of attitude toward using GPS devices (anxiety, liking, and confidence), different teaching methods also affected their scores. Independent t tests were also performed to examine the significance of the differences. The results indicated that no matter in which subcategory, the significant difference was found. The above results could mean that geocaching method helped student to reduce the anxiety and increase the liking to use GPS for facilitating their learning. Summary of independent t tests are shown in Table 5.

Variable		Ave.	S.D.	*t*	*p*
Overall Attitude	Traditional	55.48	9.64	3.03	.003*
	geocaching	60.85	11.39		
Attitude – anxiety	Traditional	15.91	3.69	2.43	.016*
	geocaching	17.49	4.04		
Attitude – liking	Traditional	12.59	3.09	2.35	.020*
	geocaching	13.86	3.34		
Attitude – confidence	Traditional	26.97	5.37	2.51	.013*
	geocaching	29.49	6.53		

Table 5. Summary of t-test on attitude toward GPS

CONCLUSION

Research on GPS geocaching is still relatively few in Taiwan. This study conducted an experiment with GPS and took the advantage of a free web resource -Google Maps. Subjects were divided into traditional and GPS-aided geocaching groups. The results showed that with different teaching methods, differences were found in both learning achievement and the attitude. The GPS-aided geocaching method exhibited a better learning performance. We believe the reason may be because the GPS-aided geocaching activity enabled a location-sensitive electronic map, which provided the direction and coordinative information, therefore allowing students exercise the practical applications of GPS and improved their ability to solve geographical problems. This result is consistent with some previous research findings that the mobile learning could resulted in better learning achievements and learning motivations (Liu, Peng, Wu, & Lin, 2009; Cheng, Hwang, Wu, Shadiev, & Xie, 2010). Moreover, a higher attitude toward using GPS devices was found in geocaching group, we believe the reason may be that outdoor geocaching allowed learners to generate curiosity, increase their motivation, and further enhance their ability to solve problems. It is also consistent with the work did by Ho & Kuo (2010).

These consistent results manifest that this study has been in line with other distinct research in mobile learning. More important, this study exemplified an affordable and innovative process which may encourage high school teacher enhancing their motivation to adopt the mobile technology in their teaching.

In summary, GPS-aided geocaching allowed the realistic situation in the daily life to be naturally embedded in the teaching activities. It also helps achieve the goal of "learn to use technology" and "learn with technology". Such results, not only academically confirms the effectiveness of mobile learning using GPS-aided geocaching method, but also should be a considerable referencing value for school administration support for future teaching activities, teaching equipment acquisitions, and for Science and Technology teachers designing their curriculum and activities.

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Student use of multimodal data and metadata tools during nomadic inquiry

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ABSTRACT

Museums and other informal environments offer rich opportunities for students to engage with scientific phenomena. Research suggests that connecting these informal experiences to classroom curricula through science inquiry can improve affective and learning outcomes. Zydeco is a mobile- and web-based program designed to connect classroom and informal settings through inquiry-based investigations. Classes plan and design their own investigations prior to visiting a museum. From prior knowledge, students generate sub-questions to help them complete the investigation, and potential tags that they could apply to the data they will collect in the museum. This information is uploaded to a mobile device that students use during the museum visit. In the museum, students conduct research, collecting and annotating data to pursue their investigation. Upon returning to the classroom, the students sort and analyze their data in order to complete the investigation. Zydeco provides several metacognitive and sensemaking supports to help students conduct inquiry mindfully as they collect data in the museum. Students are prompted to record an audio memo to explain the significance of each piece of data they collect. Additionally, students annotate the data using the tags they created prior to the field trip, or create new tags. This study of 85 middle-school students examines how these metacognitive and sensemaking supports were used by students during a field trip, and how each feature related to the quality of collected data and learning outcomes.

Author Keywords

Mobile learning, nomadic inquiry, informal learning, learner-centered design, bridging formal and informal learning

INTRODUCTION

Three overarching goals motivate science, technology, engineering, and mathematics (STEM) education : to create an informed and engaged citizenry capable of principled science-based personal decision-making and policy evaluation; to inspire and foster lifelong learners who have the ability, curiosity, and interest to pursue - in a self-directed manner - scientific topics; and to inspire and motivate talented students to pursue STEM careers with the ultimate goal of improving society and the world [16]. Those goals of STEM learning from national policy suggest that it is important for school knowledge to help students learn to navigate the real world. Learning in schools alone has not traditionally been sufficient to achieve these goals, as success in these three areas requires students to use and engage with scientific practices in contexts and settings outside of school [3].

Learning science research demonstrates that learners actively build new understandings on a foundation of prior knowledge and experience by applying and working with ideas [17]. Further, as Pugh and Bergin (2004) describe, "experience provides a foundation for learning and gives it meaning." The context in which students learn and develop understanding and skills is connected to their ability to apply that understanding and those skills [14]. This means that who students are learning with, where they are, what they are doing, what tools they are using, what their role are, and what the goals of the activity are all factor in to how they make sense of the world at any given time [14]. In this way, context - physical, sociocultural, and personal - is inseparable from learning. Thus bridging formal and informal learning environments – and helping students learn to apply their school-oriented practices and knowledge outside of the classroom – is essential.

Meeting the goals of STEM learning also requires engaging students in inquiry, the set of practices that drive new learning and the development of understanding in these fields [16]. Inquiry requires students to participate in iterative, complex investigations involving observation, experimentation, imagination, modeling, reasoning, collecting, analyzing, evaluating, and communicating about the phenomena under study [11]. Participation in these processes enables students to develop an experience-based understanding of the nature of science and scientific understanding alongside conceptual understanding.

Inquiry is complex, and in schools is structured, sequenced, and supported by teachers [12, 18]. Project-Based Learning (PBL) is one strategy used to engage students in meaningful inquiry in schools. PBL is based on four essential components: (a) a meaningful driving problem that drives student learning throughout the investigation, (b) collaborations among teachers, students, and the community, (c) investigations that support the development of artifacts to help students "learn content, represent information, and apply knowledge", and (d) technological support [11]. Although PBL-based learning environments can vary in terms of the amount of teacher guidance and student direction, they are designed to support students to develop inquiry skills and content understanding over time. In contrast, informal learning environments are often characterized by reduced structure, and are generally most effective at improving learning and affective outcomes when the experience is mediated by a learning agenda and guiding questions that afford students choice and control [1, 8].

Mobile technologies can provide new ways to scaffold inquiry [15]. Further, mobile technologies introduce new facets of choice and control by affording students the opportunity to collect data and make sense of their experiences in multimodal ways[21]. To this end, *nomadic inquiry* – technology-supported inquiry conducted on-the-go, across settings – must be carefully designed in order to guide and support students without limiting or controlling their experiences in the informal settings too excessively [9].

This research focuses on three supports for nomadic inquiry:

1. Enabling multimodal data collection

2. Prompting students to reflect about meaning of the data they collected through voice memos appended as metadata

3. Allowing students to annotate their data efficiently using tags

The first support, enabling multimodal data collection allows students to have choice and some control over how they wish to represent their data qualitatively. The second and third support students' metacognition and sensemaking by encouraging them to be thoughtful and reflective about the data they collect, and by providing cues to remind them of concepts they have learned previously in class. In this research, we explore how students use these supports to build new understandings and to make sense of their experience in the informal setting. Specifically, we investigate the questions:

• How do students use reflective voice memos and tags to make sense of their data?

• How do these metacognitive and sensemaking supports relate to learning outcomes?

BACKGROUND

Multimodal data collection

Many nomadic inquiry-type projects allow students to collect data in multimodal ways, and to engage with that data upon returning to the classroom. For example, the BioKIDS program uses handheld devices to enable students to collect numeric and classification data about organisms in their schoolyard, providing a streamlined way for students to collect and categorize their findings [20]. The MyArtSpace program (Vavoula et. al., 2009) allows students to collect multimodal information on topics defined by their teachers in pre-visit activities. Through the program, students can use a mobile phone to take pictures, record sounds, write comments, and "collect" objects in the museum by typing in the object's code number. Informal learning involves multisensory experiences; providing multiple ways through which to capture the experience may facilitate sensemaking. Collecting this multimodal data provides students with different opportunities to make sense of their experiences.

Using voice memos for reflection

Supporting reflection can help students mindfully collect and make sense of data and new information, and can improve learning outcomes [6, 7]. Reflecting on museum experiences by watching videos, looking at photos, and reviewing personal observations increases visitor learning and sense-making about the museum experience [2]. Prompting students to record audio memos immediately after collecting a piece of data in the museum may encourage careful annotation and boost conceptual understanding [19].

Using tags for efficient annotation

Several mobile programs allow students to annotate and make meaning of their data by tagging, appending notes to their primary data, or recording associated memos. Tagging, a process of selecting keywords to describe or label an information object, can enable visitors to collect and organize their data or experiences in museums for later investigation [13]. Further, the process of tagging can encourage visitors to engage in sensemaking dialogue (i.e. [5, 10, 22].

Tagging is a way to support students to efficiently make sense of and organize their data during a field. Supporting students to tag their data encourages them to focus on essential aspects of what they are observing. To better connect the informal and formal learning environments, tags can be created by students prior to the field trip. In this case, the tags can represent students prior knowledge and predictions about what they may encounter during their field trip. Using preset tags can reduce the cognitive load of sensemaking in a novel environment by restricting the evaluative scope of the experience [13].

Zydeco program design

Based on this prior research, we developed the Zydeco system, a set of tools to support nomadic project-based inquiry between the classroom and out-of-school settings such as museums, zoos, parks, and aquaria [4, 13]. The Zydeco system includes a website and handheld tools to help students and teachers plan an investigation; collect and annotate evidence, and sort and analyze the evidence in order to make scientific explanations to complete their investigations. In class, before going on a field trip, the students begin to investigate a driving question or challenge. This question or prompt is related to their science curriculum and is deep, interesting, open-ended, and feasible (i.e. it can be investigated through evidence collected during the field trip) to allow for sustained inquiry [11].

Figure 1: Parts of the Zydeco inquiry application. (top left) Driving question and sub-questions. (top right) Choosing how to collect data. (bottom left) Tagging data. (bottom right) Reviewing collected data.

The class defines sub-questions that will help them address the driving question or prompt, and predicts what evidence they might find to answer the question. These predictions will be the preset tags that students use during their field trip. The subquestions and the potential annotations are entered into the website. When students log in to the iPod Touch-based Zydeco application in the museum, their investigation - including the driving question, subquestions, and tags – is downloaded automatically to the device. Students then use the Zydeco app to capture evidence in the form of photos and audio memos to address the subquestions. Once students collect a piece of evidence, they are prompted to record a voice memo to explain why that evidence helps them answer the subquestion. Afterward, students are prompted to tag the photo using either the preset tags they defined in the classroom, or by adding a new tag or voice memo. Upon returning to the classroom, students can use the website to access, organize, analyze, and construct explanations using the data they collected.

METHODOLOGY

This study focuses on 85 seventh-graders from a diverse school district in which 56% of the students qualify for free- or reduced-price lunch. The students studied pre-historical communities and archaeology in their science and social studies classes, and attended an Archaeology Day program at a Natural History Museum. In science class, the particular focus was on how archeologists and paleontologists find and evaluate evidence to learn about the past. The Archaeology Day field trip involved ten areas where students could interact with docents and

objects and view exhibits. The ten stations were grouped three different floors, and student groups spent 35 minutes on each floor. Students collected data using the Zydeco program on one of the three floors, and used worksheets to guide their learning on the other two floors, such that one third of the students on each floor used the Zydeco program to collect data. In this study, only data from students using the Zydeco program was evaluated.

Students prepared for the field trip by using the Zydeco handheld program to completing a mini-investigation about evaluating evidence. They also were introduced to two questions: "What have we learned about the past?" and "What evidence do archaeologists use to learn about the past?" The two questions were designed to encourage students to consider how archaeologists develop theories about the past by finding and interpreting a wide range of evidence. Through a class discussion, the students identified what they knew and wanted to learn relative to these two questions in the museum. Tags were extracted from these questions and comments. For example, a student asked the question "What kinds of jobs did people have?" when considering what she wanted to know about what archaeologists have learned about the past. From this student's question, the tag "jobs" was extracted.

The two questions and these "preset" tags were uploaded to the handheld devices prior to the students' visit to the museum. Students collected primary data in the form of photos and voice memos in the museum to answer the two questions. Next, they were prompted to record an additional voice memo explaining how the photo or voice memo helped them answer the selected question. Forty-six of the students were randomly assigned one of two different types of prompts to encourage reflection. The first type of prompt was a general prompt asking "What does this evidence tell you?" The second type of prompt was specific to the sub-question, asking "How does this show how archaeologists analyze evidence?" or "How does this show you what archaeologists have learned about the past?" Finally, they were prompted on the device to label the data, either using the preset tags or creating their own, new tags.

After the experience and one day of post-visit activities, students took a post-test designed to assess their understanding of focal archaeological concepts. Student ability levels and prior knowledge was assessed through a unit test on archaeology that students had taken one week prior to the field trip. Student scores on the unit test were z-scored. Students were grouped into three "ability levels" based on this z-scored assessment: below average (.5 standard deviations below the mean or lower), average (between .49 standard deviations below and above the mean), and above average (.5 standard deviations above the mean and higher).

Students' voice memos were transcribed from each mobile device. Two researchers independently coded 10% of the overall data to establish inter rater reliability. Tags were coded based on the accuracy relative to the primary data they described (Cohen's kappa = .755; 100% agreement after discussion), the subject of the photo (Cohen's kappa = .915; 100% agreement), and whether they corresponded with voice memo explanations (Cohen's kappa =.900; 97% agreement). Voice memo explanations annotating photos were coded for relevance to the photo, accuracy, who was speaking on the voice memo, and content (94% agreement).

ANALYSIS

Each student collected an average of 5 pieces of primary data. Most of this primary data was in the form of photos (98%); only 10 voice memos were recorded as primary data. Of the photos that were recorded, 87.2% had archaeological subjects. The remaining photos were of other objects in the museum, such as geological samples, fossils, and taxidermied animals. This analysis focuses on the archaeological photos and associated metadata (tags and voice memos). See table 1 for a summary of the data that was collected by students during the field trial.

		Number *(percent)*	Average per student *(SD)*
Primary data overall	**Photos**	460	*5 (3.1)*
	Voice memos	10	*0 (0.4)*
	Photos with archaeological subjects	401 *(87.2%)*	*5 (3.1)*
Metadata: archaeological photos only	**Total voice memos**	258	3 *(3.0)*
	Accurate voice memos	238 *(92.2%)*	3 (3.0)
	Total tags	749	9 *(7.0)*
	Accurate tags	597 *(79.7%)*	7 *(5.3)*
	Preset tags	559 *(74.6%)*	7 *(6.6)*

Table 1: Summary of primary data and associated metadata collected in field trial.

Students' use of tags

Use of tags varied significantly among the students. Students could apply up to four tags per photo. Forty percent of students applied an average of only one tag to each photo, and 35% applied an average of two tags per photo. Of the 749 total tags that were used to label archaeological photos, 79.7% were accurate, suggesting that students were usually mindful when labeling their photos with tags. Nearly three-quarters of the tags that students used to annotate archaeological data were selected from the preset tags the classes created prior to their field trip in the classroom.

Tags generally fell into one of four categories: naming the object (i.e. "canoe" or "pottery"), categorizing the object in terms of what types of evidence it provided for archaeologists (i.e. "jobs" as a tag for a birchbark basket, "how tools change" as a tag for a series of stone tools organized by age, or "where people lived" for a set of artifacts found locally), describing how the object might have been used by ancient societies ("transportation" as a tag for a canoe, or "writing" as a tag for an inkwell). Occasionally, students also used tags to describe the time period or locale where an object was found (i.e. "ice-age" for a mastodon skeleton, or "underwater" for a set of artifacts recovered from a shipwreck).

Students used the preset tags that they created in the classroom more frequently than they created their own tags during the museum visit. There may be explained in several ways. First, the preset tags were created by the students, and used language and concepts related to students' prior knowledge about archaeology. Thus, using these tags to annotate data allowed students to make sense and classify the data they were collecting in familiar terms. Further, preset tags were also easier for students to use than making a new tag, as they were pre-entered, and required no additional typing. However, since the preset tags could be applied to data by just tapping on them, students may have inadvertently selected some of the preset tags. Creating a new tag is more difficult, and requires more keystrokes and thoughtful analysis as students to actively type in new information. Further evidence to support this idea is that preset tags (74.8%) were less likely to be accurate than non-preset tags (94.2%) (Chi square, $p<0.001$).

Student ability level predicted 8% of between-student differences in the percentage of tags that were accurate ($p<0.012$). This suggests that students with higher ability levels were slightly more successful at tagging their photos accurately than students with lower ability levels. However, percentage and number of total tags a student used that were preset were not significantly related to student ability.

Voice memos

The audio prompts were designed to help students of all ability levels reflect on the data they had collected before writing tags. We hoped that, by encouraging students to reflect about the significance or meaning of their photos, they would annotate their photos more thoughtfully and develop a better understanding of the concepts represented by the objects in the museum. Students were not required to record an audio memo for each photo they took, and nearly a quarter of students did not record any voice memos.

Students recorded their own thoughts on the voice memos more frequently than they recorded other students or educators on the voice memos: 17.4% of voice memos included others' voices, and 96.1% of voice memos included students' thoughts. Students recorded a variety of ideas in their voice memos. Students most frequently explained the use of the objects depicted in their data (76.0%). For example, one student recorded the following voice memo about a spearpoint: "I think it could have been used for hunting and killing and shedding animals' skin." In addition, 67.8% of the accurate voice memos included students naming their data. For example, a student recorded the memo "It's a mummy" to annotate a photo of a model of a mummy. Students occasionally described what or how a scientist would learn from the depicted object. For example, one student recorded a memo about a photo of a series of primate and human skulls, stating, "These are the skeletons of primates to see how similar human are to primates, and so we could have evolved from them." This type of idea was included in only 5.2% of the voice memos recorded. In 11.2% of voice memos, students recorded affective reactions, such as: "These are the diagrams of their houses and how big it was and how it was like, and its really cool!" For 6.3% of voice memos, students made connections between the data and everyday life. For example, one student recorded the following memo about a gorilla skull: "I think this is a gorilla with crooked teeth, because they didn't have braces back then, and I think this is a gorilla." Only one student read the label of an object as a voice memo. See table 2 for a summary of how students used the voice memos.

Students with higher ability levels included more information in the comments they recorded on their voice memos ($p<0.001$). For example, one student said "I believe this here is a toy of a spinning top, and I also believe that this is a toy because of the fact that I can't find …I don't believe I can find any other use for a top that spins around at such small size with a whip that contains how it can spin around. I think it was used for child entertainment. And that's my hypothesis." This student named the object, explained its use, and then made connections to his understanding of how such objects are typically used today. In contrast, a typical comment by a lower-ability student included limited information. For example, when describing a similar display, a

lower-ability student stated: "These are bones." Higher ability-level students were also more likely to express affective reactions in their voice memos than average ability and low ability students (p<0.05).

			Total	**Ability level**		
				Above average	**Average**	**Below average**
Number of students using voice memos			58 (77.3%)	18 (66.7%)	18 (81.9%)	22 (84.6%)
Number of inaccurate / incomplete voice memos			20 (8.8%)	14**	3**	3**
Number of accurate voice memos			208 (91.2%)	70	62	76
Frequency category of infomation recorded in accurate memos (percent within accurate memos for each ability level)	**Recorded others**	Docent talking	32 (15.4%)	10 (14.2%)	10 (16.1%)	12 (15.8%)
		Other student	6 (2.9%)	4 (5.7%)	3 (4.8%)	4 (5.2%)
		Total	49	17	14	18
	Recorded self	reading a label	1 (0.5%)	0	0	1 (1.0%)
		naming an object	141 (67.8%)	53 (75.7%)	35 (56.5%)	53 (69.7%)
		explanation of use or meaning of objects	158 (76.0%)	51 (73.0%)	47 (75.8%)	60 (78.9%)
		Explanation of what or how scientists learn from objects	11 (5.2%)	1 (1.4%)	5 (8.1%)	5 (6.6%)
		affective reactions	23 (11.1%)	3* (4.3%)	5* (8.1%)	15* (19.7%)
		making connections	13 (6.3%)	3 (4.3%)	3 (4.8%)	7 (9.2%)
		Total	347	111***	95***	141***

*=p<0.05, **=p<0.01, ***=p<0.001

Table 2: Characteristics of voice memos recorded by students of different ability levels.

The total number of voice memos, and the likelihood of a student recording a voice memo was not related to students' ability level. In addition, there was no significant relationship between the number of accurate voice memos recorded and student ability. However, the number of incorrect or inaccurate voice memos a student generated was related to the ability level of the student (p<0.01). Lower-ability students were more likely to record inaccurate voice memos.

Finally, in this study, forty-six of the students were randomly assigned mobile device with either general or specific prompt. We analyzed how these different types of prompts impacted student data collection strategies. Chi-Square tests showed that the number of voice memos recorded by students and the accuracy of voice memo recorded were not significantly related to the type of the prompt students received.

Relationship between tags and voice memos

Overall, 76.5% of students used voice memos, and 68.5% of tags were accompanied by voice memo metadata. The number of voice memos used per photo had a small but significant correlation with the number of tags used per photo, indicating that students who used voice memos more frequently were likely to use more tags than students who used fewer or no voice memos (r=.268, p<0.014).

Each tag was coded by how closely it corresponded to its associated voice memo (See table 3 for a summary of the relationship between the tags and the voice memos). Tags were coded as directly related if they repeated language used in the voice memo, or if the tag and the voice memo could be directly categorized together. If the tag and the voice memo were related but could not be categorized together, they were classified as indirectly related. For example, one student recorded a voice memo about a photo of a flour grinding stone: "It was used to grind food into flour." She tagged the photo "getting food" and "cooking". These tags were classified as directly related to the voice memo. She also tagged the photo "farming," which was classified as indirectly related because grinding flour was associated with farming societies, but grinding flour is not a part of farming. If the tag and voice memo could not be associated together, the tag was classified as not related to the voice memo. For example, one student annotated a birchbark basket with the memo: "I think they would have to weave something make baskets." She tagged the same basket "ideas of beauty." This tag was classified as not related.

	number of tags (percent)	number of accurate tags (% of tags in category)	number of preset tags
Tags not accompanied by a voice memo	236 (31.5%)	208 (88.1%)	136 (57.6%)
Tag not related at all to the voice memo	196 *** (26.2%)	92 (46.9%***)	185 (94.4%*)
Tag indirectly related to voice memo	67 ***(8.9%)	59 (88.1%***)	62 (92.5%*)
Tag directly related to the voice memo	250 ***(33.4%)	238 (95.7%***)	176 (70.4%*)
Total	749 (100%)	597 (79.7%)	559 (74.6%)

(=p<0.05,   ***=p<0.001)*

Table 3: Summary of relationship between tags and voice memos

Among the tags that were associated with voice memo metadata, one-third of the tags students chose were directly related to the audio memos that they recorded. Tags that were directly or indirectly related to the audio memos were significantly more likely to be accurate than tags that were not directly related to the audio memos (See table 3; Chi square; $p<0.001$). Further, tags that were directly related to the voice memo were less likely to be preset than tags that were not related or indirectly related to the voice memo (Chi square; $p<0.03$).   There may be two explanations for this.   First, students who used tags to summarize their voice memos may have created tags in order to more directly represent the content of the voice memo.   Tags that were categorized as directly related to the voice memo are also less likely to have been inadvertently selected by students, and, as mentioned previously, preset tags were easy to accidentally append to photos. Indeed, preset tags were significantly less likely to be accurate when they were not related to the voice memo (45%) than they were if they were indirectly (89%) or directly (95%) related to the voice memo ($p<0.001$).   There was no significant relationship between student ability level and how or whether their tags corresponded with voice memo.

Sensemaking supports and learning outcomes

Our last set of analyses addresses the question of how different sensemaking supports – voice memos, tags, and archaeological photos – relate to student learning outcomes when controlling for prior knowledge and ability.   In each analysis, we controlled for prior knowledge and ability using the z-scored grade on their pre-program unit test on archaeology.

Our analysis showed no association between the number of accurate voice memos, photos, or tags used and learning outcomes when controlling for ability.   This may be explained because the amount of data collected by each student varied dramatically (See table 1).   However, the percent of tags a student used that were accurate was associated with higher learning outcomes, when controlling for prior knowledge and ability ($B=5.124$, $p<0.041$). In other words, a 10% increase in tag accuracy was associated with a 0.1 standard deviation increase on the post-test score. This suggests that, mindfulness during the process of tagging – analyzing and annotating what they saw in the museum in terms of their prior knowledge and new understandings   - was associated with higher learning outcomes. Thus, tagging may encourage some students to be more mindful about their experience in the museum.

DISCUSSION

This research supports three main findings:

- Both reflective voice memos and tags can support student sensemaking during nomadic inquiry, in complementary but different ways.
- The use of voice memos and tags varied greatly among students regardless of levels of prior knowledge and ability, although higher-ability students recorded a higher density of information when they recorded their own thoughts in voice memos.
- Reflective voice memos has the potential to support mindful tagging for some students, but may encourage careless tagging among other students.

Student use of the Zydeco tool varied dramatically within and between students of different levels of prior knowledge and ability.   The number of photos collected by a student varied from 1 to 16, and student use of tags and voice memo metadata varied greatly.   Zydeco allows students flexibility and choice in the amount and type of data they collect.   However, the small amount of data collected by some students suggests that some students may not have understood the purpose of data collection, or may not have felt comfortable with using the program [4].

Students used voice memos for different purposes. Some voice memos recorded docents' or peers' conversation, while others involved student's comments with different degrees and types of sense-making. The usage of voice memo and the accuracy of voice memos are not significantly dependent on students' ability level, which indicates that the Zydeco system accommodates differences in learning styles across ability levels. On average,

students primarily used voice memos to name the objects, or explain the usage of the objects, regardless of students' ability level and prior knowledge. Surprisingly, students with the highest level of prior knowledge and ability made more affective comments on voice memos compared with other two lower levels of students. This suggests that students with higher ability and prior knowledge were personally engaged with the exhibits, while students with lower ability levels and prior knowledge levels were less likely to engage in this way with exhibits through data collection.

Nearly all students used both preset tags and created their own tags for photos, regardless of prior ability level. Preset tags were less likely to be accurate than the non-preset tags. The most likely explanation for this is that selecting preset tags could be done easily and did not require the mindfulness required to type in a new tag. Supporting this idea, among preset tags that were associated with voice memos, those that corresponded either directly or indirectly with voice memos were more likely to be accurate than preset tags that were not related at al to the voice memo.

The percentage of tags used that were accurate was positively related to learning outcomes when controlling for student ability levels. This suggests that mindful data annotation in the museum can support learning across settings. Tags that were directly or indirectly related to voice memos were more likely to be accurate than tags that were not related to voice memos or tags that were not associated with a voice memo. This suggests that, for some students, prompting voice memos to reflect on data collected prior to tagging has the potential to encourage mindful tagging. However, for other students, a high percentage of tags were unrelated to the voice memos and inaccurate. For these students, recording voice memos seems to be related to carelessness in tagging, perhaps, due to the redundancy perceived in recording both voice memo and tag metadata.

CONCLUSIONS

By prompting students to annotate their primary data with voice memos and tags, the Zydeco system may encourage students to be more engaged during their investigation, and helps them to collect hands-on and minds-on data. Although preset tags provide students access to prior knowledge and can help students connect the museum experience to their formal experience and learning, some students seem to apply these preset tags carelessly. Since the percentage of tags used that are accurate is related to learning outcomes, more research is needed to support students to use these tags mindfully.

In conclusion, most students used photos, tags, and voice memos in a variety of different, yet complementary, ways to support sensemaking. Affording this variety of data collection can help student with different learning styles engage in data collection, and permits students to personalize their own record of their nomadic inquiry.

ACKNOWLEDGMENTS

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Let the Students Lead the Way: an Exploratory Study of Mobile Language Learning in a Classroom

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ABSTRACT

This paper describes an exploratory study that was conducted at an international school using a mobile application designed to support situated mobile language learning. The mobile application, called Cloudbank, supports a repository for words and expressions that can be shared by several users. The study was started where the application was used for a limited activity within the classroom, which is using figures of speech in English. The students were given the freedom to explore the functionalities of the application, the affordances of the mobile device as well as to use it for other activities. The teachers initially believed that the application will be beneficial for learning figures of speech in English. The study revealed that Cloudbank is beneficial for supporting learning in several areas, collaboration among students and ownership of the knowledge leading to retention of the knowledge. It also highlighted how the technology stimulated discussions about the cultural aspects of languages. This paper presents an overview of the exploratory study and the observations.

Author Keywords

Mobile Language Learning, Collaboration, Figures of Speech, Language and Culture, student-centered.

INTRODUCTION

This paper describes an exploratory study that was conducted at an international school using a mobile application designed to support situated mobile language learning. The mobile application, called Cloudbank, supports a repository for words and expressions that can be shared by several learners.

The popularity of mobile technologies such as mobile phones, Personal Digital Assistants (PDAs) and portable media players in education have been documented by several researchers (Roschelle, Sharples & Chan, 2005; Naismith *et al.,* 2005). Language learning has been an area where technology, in particular mobile technology in recent times, has been popular. Initially, mobile-based language learning services focused on providing instant help in either obtaining the meaning of a word (Morita, 2003) or help in pronouncing a word. Later, improved support was provided by partial personalised learning such as supporting pronunciation of specific sounds for specific user groups, e.g. (Uther, Zipitria, Uther, & Singh, 2005) and (Ogata, H., L. H. Gan, et al., 2008). Mobile learning denotes learning that is conducted while the learner is on the go or when the learner is mobile (Sharples, Taylor, & Vavoula, 2005). This involves providing easy access to appropriate learning resources. Thus, there has been considerable focus on personalisation and contextualisation of learning resources accessible via mobile devices. For example, the location and a user's preference of learning resources are defined using a user profile in (C.-M. Chen, Li, & Chen, 2007); additional parameters such as the user's behaviour, the device and the environment are considered in (Paredes, Ogata, Yano, & Martin, 2005) and the user's learning interests and user groups are considered in (Petersen, Markiewicz & Bjørnebekk, 2009).

Mobile learning emphasizes the active involvement of the learner where formal learning is complemented by informal learning. This is well in line with the constructivist thinking where the learner needs to experience and apply concepts and relate them to their existing body of knowledge. In particular, social constructivism (Vygotsy, 1978), which focuses on the social context that shapes the construction of knowledge, is important in language learning. While there is support for personalised language learning, there are very few applications that focus on the collaborative aspect of language learning. The Cloudbank application used in this study is

designed to support the sharing of content among language learners. The aim of the system was to develop a mobile (Android) app that would enable advanced language learners to collect and describe multimedia language and culture-related content they came across in everyday life within their target language culture. The content is then uploaded to a repository that is accessible by other Cloudbank users, thus enabling sharing of learning content among several language learners (Pemberton, Winter & Fallahkhair, 2009). Cloudbank provides a medium for learners to create their own "wordlists", which contains words and expressions with the learner's descriptions of them in specific contexts. Thus, the learner is able to share their understanding of a word or an expression through their experiences with peer learners.

The aim of this paper is to describe an exploratory study that was conducted at an international school, in the classroom, using the Cloudbank application. The main objective of the study was to evaluate if the Cloudbank application is beneficial to the learning of the students and to explore how such mobile applications can support the learning and the pedagogical approach. The study was started where the application was used for a limited activity within the classroom, which is using figures of speech in English. The students were given the freedom to explore the functionalities of the application, the affordances of the mobile device as well as to use it for other activities. The teachers initially believed that the application will be beneficial for learning figures of speech in English. In this study, the teachers took a back seat approach and let the students lead the way. The study revealed that Cloudbank is beneficial for supporting learning in areas other than what was initially anticipated.

The use of the Cloudbank application proved a success in the classroom and it revealed a number of interesting issues about using ICT and mobile technologies in the classroom, which are both social and pedagogical in nature. Some of these address collaboration among students and peer support among the students, ownership of the knowledge leading to retention of the knowledge as well as how the students appropriated the technology into the different learning activities in the classroom. It also highlighted how the technology stimulated discussions about the cultural aspects of languages. This paper presents an overview of the exploratory study and the observations. We are currently conducting a qualitative evaluation of the study.

The rest of this paper is organised as follows: Section 2 describes the case, Section 3 describes the design of the study, Section 4 discusses the observations during the study, Section 5 presents an overview of the design of the evaluation process and Section 6 summarises the paper.

CASE DESCRIPTION

The study described in this paper has been conducted at the Trondheim International School (THIS), who provides an international education in English, based on the International Baccalaureate (IBO) program. The study was conducted with the students in Year 4. There were 28 students who are 9 or 10 years old. The students represented a diversity of cultural backgrounds; there were students from 12 different countries and as many as 10 different languages are spoken by the children. Apart from 2 students, English is either their second or third language. Several of the students have parents from different backgrounds; thus they are used to a multi-lingual home and school community. The class teachers are native English speakers from Australia.

The IB pedagogical approach uses an enquiry based mode of teaching and learning where the students learn by enquiring into a topic or a theme, called a Unit of Inquiry. The main subjects in the curriculum are Literacy, Mathematics, Norwegian (as a second language), and the Unit of Inquiry. Other traditional subjects such as Geography, History and Science are studied through the Unit of Inquiry, which helps to focus the learning efforts in Literacy, Mathematics and Norwegian around a specific topic. The classroom is arranged in such a way that students can gather around and work in small groups. Several learning aids such as the PC, reference books and other material are made available for everyone and students are encouraged to move around the classroom to obtain what they need for their work.

In the classroom, the students have access to a PC with internet access and a Smartboard. Cloudbank was made available to them on 5 HTC Desire HD mobile phones. The study took place from the first week of March until the second week of June, 2011. The students were introduced to Cloudbank using the repository of words that were available at the beginning of the study. This included some Figures of speech and a few words with pictures to describe them.

This was the first time the students had access to mobile phones in their classroom as a part of their studies. Some of the students owned mobile phones; however they had not used it for anything related to their studies.

STUDY DESIGN

The study was an exploratory one. When the study was started, the class was working on figures of speech for literacy. Since the Cloudbank repository contained some figures of speech, it was decided that it was natural to start using it to support the students to learn figures of speech. To start with, the students were allowed to use it for learning figures of speech and new words for an hour everyday. To ensure that all the students had an equal chance of using the system, the students were divided into 5 groups (only 5 devices were available) and the student took

turns in using the phones. The class kept a log of who was using the system to ensure that there was equity of usage. Another reason for restricting the use of the devices for a specific activity at a specified time was also to ensure that the students used the devices for Cloudbank and to maintain focus on the application rather than the gadget and all the other affordances of the mobile phone.

As the students got more comfortable using the system, they were allowed to use it more freely at any time during the class. At this point, the teachers decided to let the students take more control of their use of the system and be open to see what other parts of the curriculum could also be supported by the use of Cloudbank. The students were also allowed to use the mobile phones for other activities such as taking photographs.

The Cloudbank technology was demonstrated to the class by one of the students who had been exposed to the system earlier. It was demonstrated using the web-based widget, using the Smartboard. The basic functionalities of the system, which are adding new content to the repository and browsing through the content, were shown. Once the students started using the mobile phones and became confident using the system, they helped each another. The teachers took a back seat and let the students have control of the situation.

OBSERVATIONS

As mentioned earlier, this study was an exploratory study to observe how a mobile application may benefit the students and support their learning process. A summary of the main points that were observed during the study are as follows:

- Mobility and accessibility

- Appropriation of the technology

- Collaboration among students

- Additional source of reference

- Ownership

The following sub-sections provide a brief discussion on the above four points.

Mobility and Accessibility

Mobility has often been described in terms of physical space or location and time (Cooper 2001). More recently, Sharples et al. have elaborated on the mobility that we are concerned with in Mobile Learning as mobility in physical space, conceptual space, social space and of technology (Sharples, Arnedillo Sánchez et al. 2007). Kristoffersen and Ljungberg have illustrated mobility in the physical space further by introducing the notion of modality of mobility as the fundamental pattern of motion (Kristoffersen and Ljungberg 1998). They propose wandering, travelling and visiting as the main patterns of mobility. Another aspect of mobility among learners come from the fact that learning is facilitated by communities and that learners move between communities (Petersen and Divitini 2005).

In our study, since the learning arena that we have been interested in is confined to the classroom and the devices remained in the classroom, the physical mobility of the learners was restricted to the classroom. Initially, since the students were allowed to use the mobile phones in a dedicated area of the classroom, the students moved to the place where the mobile phones were located to use the system. Once, the students got more used to the system, the students continued moving to the mobile phones and bringing them to the place in the classroom where they were working. The students did this whenever they came across something they could add to the Cloudbank repository. Similarly, if they were looking for a word or a phrase, they began to check if they could find that in the Cloudbank's repository before they checked other sources. This behaviour connects the ease of access or the accessibility of the learning material to mobility. The students found it easier to access the Cloudbank repository rather than other sources such as dictionaries, reference books or the Internet, which were also available in the classroom. The ease with which they could move the source, which in this case was available on the mobile phone, made that the first choice for the students.

In addition, the easy access to learning material via the Cloudbank application made it easier for the students to browse and search for learning material as well as add content. In particular, for students who were a bit shy to ask someone, the Cloudbank application encouraged them to use it for browsing content as well as to contribute content.

Appropriation of the Technology

The notion of appropriation is often used in socio-cultural learning theory. A good overview of technology appropriation in collaborative learning is provided in (Overdijk and van Diggel 2006). The authors quote several definitions of appropriation, highlighting the different aspects of it such as adapting something to ones own use

and the way technologies and their uses are shaped through the users' interaction with the technology as well as the social interactions.

In our study, Cloudbank was introduced to the students for a specific task. However, they were given the freedom to explore the functionalities of the application as well as the device. The students had been active in doing this and thus had appropriated the technology for use in other learning activities. The students started using Cloudbank for explaining figures of speech, using textual descriptions. An example of an entry contributed by one of the students is shown in **Figure 1**, a. After a few weeks of using Cloudbank, the students started exploring additional capabilities in the application. They discovered that it was possible to add pictures in addition to the text to describe a phrase; an example of such an entry in Cloudbank can be seen in **Figure 1**, b.
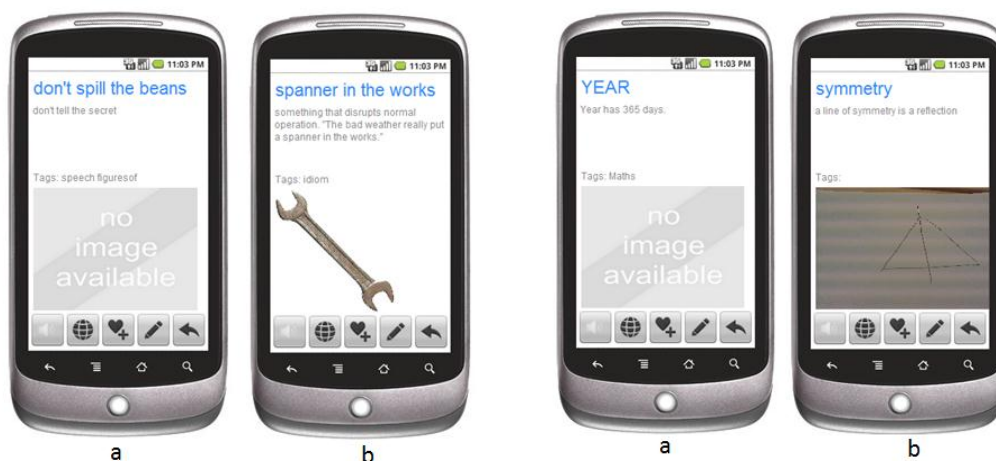
Figure 1: Example of Figures of Speech in Cloudbank   Figure 2. Examples of Maths terminology in Cloudbank

While using Cloudbank for figures of speech and new words and phrases in English, the students realised that they could also use it for their Maths. When they came across a new maths term, the students started using Cloudbank to collect and share their maths terminology, see **Figure 2   Figure** . Unlike some words and expressions, maths terms often have precise meanings, which can be illustrated through a diagram. The students discovered that they could use the camera on the mobile phone to capture a drawing to illustrate the meaning of the term and upload it to the Cloudbank repository, see **Figure 2**, b. Note that the students have also started using the functionality "tags" to distinguish the category of the content; e.g. "figures of speech" or "idiom" and "Maths".

In addition to using Cloudbank for the different types of words, it spurred discussions around the figures of speech, stimulating the students to compare them to similar ones or what a similar expression may mean in the other languages that they spoke. Students with a second language quickly found that cloudbank could support other languages too and it was very motivating and rewarding for them to have their own language recognized. This created a bridge between home languages and classroom learning. This also brought in the dimension of language and culture, enhancing the cultural awareness among the students as well as contributing to their knowledge of other countries and their cultures.

Collaboration among students
The students discovered that they could edit the content in the Cloudbank repository and started editing each other's work. They took pride in telling the original contributor of a word or a figure of speech that they had added to the original description in the Cloudbank repository. Collaboration also included extensions of each other's entries, discussion and debate regarding definitions of figures of speech resulting in clearer understanding and an acknowledgment of another's perspective. Students had to defend their information in discussions with each other and together they often came to an agreement of the best definition.

The students were proud that they have helped someone else learn something from them. The shared repository supported in the Cloudbank application provided a means of collaboration through the shared content and collaborative contribution of editing of the content. The students also edited others' contents while browsing by correcting the mistakes of others. This was indirectly evaluating the work of peers or learning from your peers.

The students explored the functions of Cloudbank in a guess and check manner with no fear of failure and they shared their mistakes and discoveries with each other. This is not found in a classroom using traditional reference material.

Additional Source of Reference

Often students are reluctant to use a reference tool particularly a dictionary. However, using Cloudbank, this wasn't the case due possibly to two factors: (i) they were motivated to use the technology; (ii) they were not singled out as not knowing something because they could have been either adding to, or looking for information. The students realised that knowledge could be extended and refined unlike a dictionary or a set body of work. They were creating knowledge and not just gaining knowledge. This was a real life opportunity to enhance student awareness of how a google site needs to be checked for accuracy.

As the focus was adding to a body of knowledge with figures of speech, the students were hyperaware of figures of speech in their environment. They would come to school with figures of speech from movies, from books they were reading and from their parents' language.

In general, the use of cloudbank encouraged the attitude that it was acceptable not to know something. Instead of ignoring a word or phrase you didn't know, it was possible to find out an answer, then add this to the class repository, whereby doing so would not only help yourself as a learner but possibly other class members as well.

Due to the low threshold of appropriation of technology, the teachers were able to incorporate a new reference material utilising traditional research skills. The technology had general high interest with everyday familiarity. Compared to the dictionaries, the students found it much easier to locate words in Cloudbank and to manipulate the mobile phone. The technology came in as an aid to an already existing program within the classroom. As the teachers observed the use, discussion and collaboration, the benefits of Cloudbank and its possible use as a learning tool, they incorporated it further into the class program.

Ownership

The Cloudbank application was introduced to the class by one of the students. She demonstrated the basic capabilities to browse through the contents in the repository and to add content to the repository. At the beginning, the student who first introduced the application felt that she was the class' Cloudbank champion. She felt a degree of ownership of the technology and that she was the most knowledgeable among the students in using the technology. However, after one or two weeks, the other students caught up with her and felt comfortable with the technology. The students felt that the Cloudbank was their own as they could add content and thus they felt ownership of the knowledge in the repository as the repository was created by them.

The students took responsibility for the resource. The teachers never had any problems returning, charging or with misuse of the technology. The technology became a respected part of the shared classroom.

EVALUATION

An evaluation was conducted at the end of the study to capture the students' impressions about Cloudbank and to understand how it may have contributed to their learning. The evaluation was conducted in three parts:

(i)   A plenary discussion, led by one of the class teachers, where the students provided keywords on what they thought about Cloudbank. The aim of this was to get all the students focussed on the Cloudbank experiences and get them ready for the evaluation. This discussion was captured as a set of words and expressions on the whiteboard, as shown in **Figure** .

(ii)   Group discussions, where the students were split into three groups, each one focusing on a different topic. The three topics were "Collaboration", "Function and usability" and "How did it help the teachers?" Each group had a chance to contribute their ideas on each topic, for 15 minutes. Each group discussion was facilitated by a person that was not involved in the classroom teaching, i.e. two researchers from the university and one school teacher. This was to ensure that the students were not influenced by their class teachers. Here, the students were allowed to contribute their ideas and share their experiences with Cloudbank.

(iii)   Individual questionnaires, where each student had to fill in an individual, semi-structured questionnaire. While the group discussions provided a lot of information, it was decided that the individual questionnaires would provide more qualitative and quantitative data as well as ensure that each individual student had the opportunity to contribute to the evaluation. While most of the questions had choices to cross off or smiley faces to indicate a scale, the students were also able to add comments for additional information. The questionnaire was designed to gather data on the attitudes, behaviour, the knowledge and skills and the impact of the Cloudbank application on the students' learning.
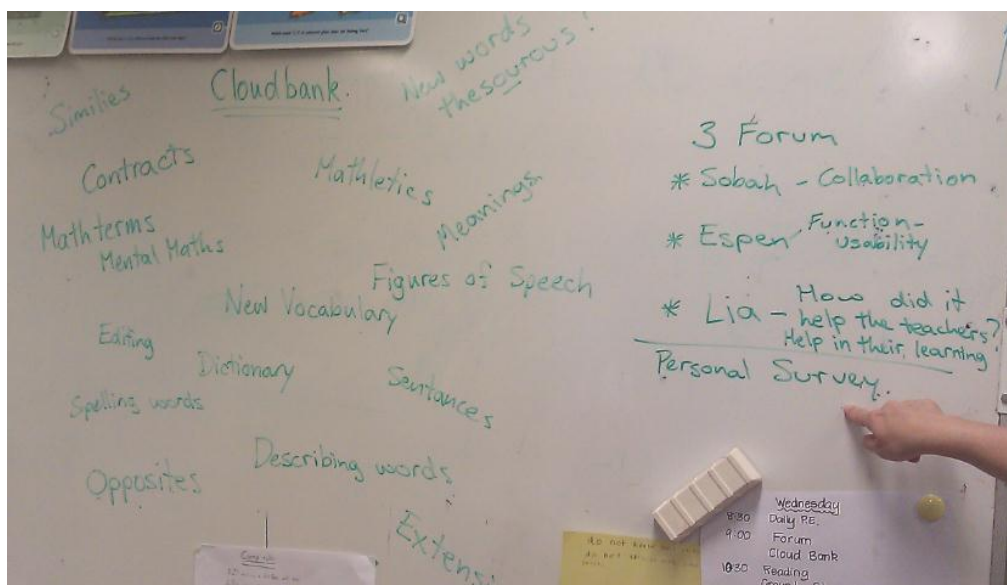
Figure 3. Keywords describing the students' impressions of Cloudbank

We are currently analysing the data from the evaluation. Thus it is not possible to include any data in this paper. However, it can be concluded that the study was a positive experience for both the teachers and the students. As can be seen from **Figure 3**, the students had used it for a number of different activities some of which have been described in the previous sections

SUMMARY

The exploratory study using the Cloudbank application in a classroom showed that the technology supported learning in areas other what was initially anticipated. Initially, the teachers let the students use it for one hour everyday, for learning Figures of speech and new words to improve their spelling and knowledge of the English language. However, over a very short time, the students had appropriated the technology to support them in their maths terminology, to learn and understand figures of speech in their own languages as well as Norwegian, which was the second language in the school. Through the figures of speech, it also stimulated discussions among the students on the cultural use of languages and the comparison of metaphors in the different languages.

The students collaborated in their work by supporting each other in using the Cloudbank application. More importantly, they collaborated through the technology by editing and extending each other's work and by learning from each other's contributions to the Cloudbank repository. Cloudbank quickly became an important source of reference in the classroom that the students felt proud of and responsible for.

The teachers believed that the Cloudbank application supported the learning process of the students in several ways. The fact that the students had to create the repository by adding the content, it helped the content become imprinted in their minds. Since the students created the repository, they felt ownership of the knowledge and this was reinforcing the knowledge and helped them retain what they had learned. It contributed a lot to the learning as they owned the knowledge, they understood it and they were motivated to reference it and improve it. The Cloudbank application helped increase their vocabulary and improve their spelling as well as increased their understanding of the math terminology.

During this study, one of the strengths of the Cloudbank application was seen as its simplicity and ease of use, making it extremely easily to adopt in the teaching practice in the class and it proved very easy to be integrated into the learning activities in the classroom. The teachers felt comfortable to adopt it in the classroom without a long trial period and the students had a very low threshold in starting to use it. From the teachers' perspective, a routine activity of using Cloudbank became an engaging activity generating smiles and a positive class atmosphere.

This study also provided a positive impression of using mobile technologies and applications within a classroom. It highlighted a different aspect of mobility and accessibility and it showed the fine balance between the application and the technology or the gadget. There was a very clear purpose for which the students could see the value of Cloudbank; other students were using their work, so they could see the immediate purpose and the need for accuracy.

This paper presented a very brief overview of the observations made during an explorative study of using a mobile language learning application, Cloudbank, in a classroom. We are currently analysing the results from the

evaluation of the study conducted using questionnaires and focus groups with the students. Based on the positive experience from this study, we also plan to continue using the Cloudbank application in the school and to conduct a similar study with younger children.

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Short Papers

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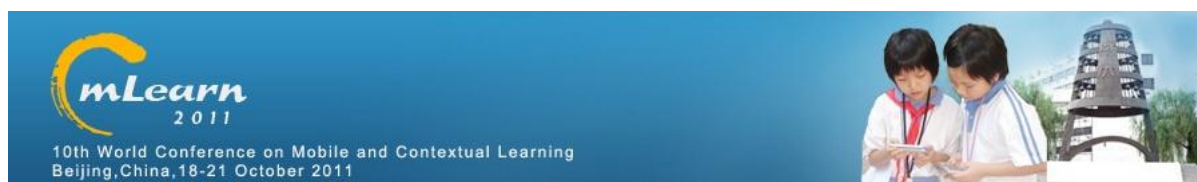
Smartphones in Clinical Nursing Practice: What are the benefits and the challenges?

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ABSTRACT

Nursing students at the University of Calgary – Qatar are nearly all English as second language (ESL) students with Arabic as their first language. During the undergraduate nursing program students are required to work with patients in clinical settings under the supervision of a faculty member. One of the main goals of clinical courses is to provide students with the opportunity to learn in context and 'just-in-time', a much more realistic and memorable learning experience. Learning often requires students to acquire additional information about patients on site. However, most clinical placements in Qatar do not provide students with access to textbooks nor computers and the nature of the settings does not allow them to carry e.g., textbooks with them. The current research was conducted to determine if properly selected smartphone technology and accompanying software would help provide students with information they needed in a just-in-time fashion and if this would have a positive impact on their learning. A selection rubric was developed to ensure the most appropriate smartphone and software was purchased. The smartphones and accompanying software were purchased and deployed to students in two clinical courses. Data was gathered through focus groups at the end of the semester. Both students and faculty commented favourably on their use in clinical practice especially in terms of being able to quickly and immediately access information. Students also identified that while smartphones were appropriate for just-in-time information gathering they were not a replacement for the depth of information available in textbooks.

Author Keywords

Smartphone, nursing, clinical practice, second language, selection rubric, just-in-time, learning

INTRODUCTION

There are many case studies that explain successes and the proliferation of mobile technology use in nursing. Personal Digital Assistants (PDAs) are in use by most medical professionals as clinical reference tools (Wyatt et al., 2010) and are commonly used in practice to give access to reference databases, patient and drug information, and decision support systems (Farrell & Rose, 2008). PDAs have been "introduced and evaluated in a variety of clinical environments from critical care to home health care" (Farrell & Rose, 2008, p. 13), so it is relevant for future nurse leaders to learn how to include them in their practice. Research also shows that "the use of PDAs built confidence among students and increased motivation" (Goldsworthy, 2006). Further, MacKay & Harding (2009) demonstrated that use of SMS messages with nursing practicum students assisted with motivating, supporting and communicating with students. Kenny, Van Neste, Park, Burton, and Meiers (2009) explain that "m-learning has the potential to bring the instructor, peers and resources together virtually at the point-of-care, especially when indirect supervision models are used, to support the students' safety and evidence-informed practice" (p. 76). There is sufficient use of mobile technology in nursing to warrant their use in the University of Calgary – Qatar undergraduate nursing program.

PROBLEM

Currently, nursing students at University of Calgary – Qatar are limited in their ability to access relevant health care information in clinical placement settings. Few reference texts are available at clinical sites, and library electronic resources are generally not available or accessible in the clinical setting. As well, most our students' second language is English with their first language usually Arabic.

In a typical clinical scenario, instructors assign patients to students the day before and then require students to learn about the case, pathophysiology and medications prior to caring for the patient. In many cases, however, the

patient will have been discharged before the student arrives the following day, thus requiring the student to start with a new patient on the spot.

Further, a significant part of clinical experiences is the 'just-in-time' nature of the learning. Students often encounter complications in cases ranging from changes in patient presentation to changes in medication to changes in diagnosis and treatment. Unfortunately, with little or no access to books or computers in clinical settings, it is difficult or impossible for students to update their case knowledge. Faculty felt that teachable moments and learning opportunities were lost as students were required to note issues and follow-up after the clinical session, typically hours or even days later.

Smartphones provide access to information immediately through wireless and 3G connectivity or through applications installed on the smartphone. The key to the success of clinical learning situations was the 'just-in-time' access to information that smartphones could provide.

METHODOLOGY
The project was conducted in three stages: (1) selecting the most appropriate smartphones and software, (2) targeted deployment of smartphones and (3) evaluating the success of the smartphones.

Technology Selection
There are a number of smartphones available on the market today, each with its own set of features. In order to select the most appropriate smartphones for use in the targeted courses (e.g., clinical placements) a smartphone selection rubric was created and revised with feedback from the research team which included faculty teaching clinical courses. A number of primary and secondary characteristics were included in the rubric including size, portability and connectivity resulting in the selection of the Samsung i9000 smartphone.

Software Selection
The course selected for initial deployment of the smartphones was a clinical course which required students to retrieve information and be knowledgeable about patients' medical issues. The most appropriate software was deemed to be Skyscape (a modular program that includes drug guides, disease guide, medical dictionary, etc.). Faculty members recommended the modules most appropriate for the clinical courses that had been targeted for deployment. The software was installed on the smartphones prior to deployment.

Deployment
Due to budget constraints only 12 smartphones could be purchased. Three smartphones were given to faculty with nine going to students in the clinical course. In all there were 14 students in the course so not all students were given a smartphone. At least one student declined to take a smartphone, stating that they did not want the responsibility of having one. Students and faculty kept the smartphones for the remainder of the semester.

One smartphone was given to a student in a Community Health Practice clinical. However, because of the small sample size and the short duration of the partial semester, nothing could be concluded from this portion of the trial.

Evaluation
At the end of the semester a focus group was conducted with faculty members involved in the project followed by a focus group with students. The focus groups were intended to gather feedback about the impact the smartphones had on the faculty and students in the course. The focus questions were similar for both.

RESULTS
Both students and faculty commented on how useful the smartphones were in providing information as needed, especially when patients had been discharged and new patients assigned. Students used Skyscape extensively to access information regarding, for example, pathophysiology and drug guides.

Both groups felt that a small amount of training would have been beneficial in terms of using the smartphones and software. Virtually all felt that having them available in clinical was clearly an appropriate use.

Some students also used the internet capability to access, for example, YouTube videos that illustrated content that was relevant to their patients. When asked how they used the smartphones at home, students claimed they used them very little, but with prompting, some did say that they used the medication software to look up medications that family members had been prescribed. Of course, this feedback only came from the nine students who had the smartphones.

Towards the end of the focus session, several students began to discuss how they saw smartphones fitting into the overall framework of practice. They felt Skyscape was great for quick, simple-to-understand information but that it lacked depth. They suggested textbooks were more appropriate for providing the depth of information they were seeking. They did not feel that putting books on smartphones was appropriate as the viewing area was too small and too hard to read. They preferred print books for this purpose.

DISCUSSION

This project represented a systematic approach to the selection and implementation of smartphones in the clinical course based on content and need. The student and faculty feedback during the focus group sessions supported the hypothesized match between technology and need. Student feedback suggested smartphone use, at least in the context of this course, was good for just-in-time information and was entirely appropriate given that context. However, they did not feel smartphones were appropriate as viewers for reference books.

Without prompting students discussed a pyramid of use that suggested the technology most appropriate for varying depths of information (see figure 1). Although the model is not detailed, it may provide some guidance in selecting the best technology for just-in-time versus in-depth use.
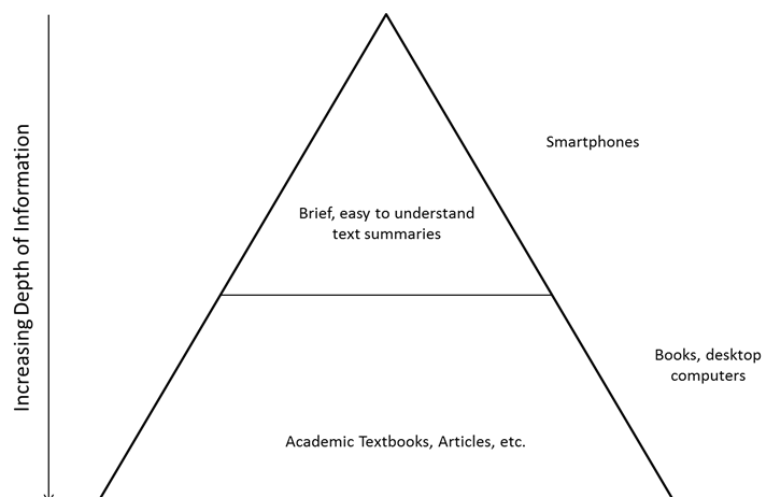
Figure 1. Depth of information versus best viewing technology

CONCLUSION

Every attempt was made to select appropriate technology for a clearly defined need and yet ensure the technology would have wider application within and throughout the nursing program. The process that was adopted for selection and implementation was inclusive and worked well. Student and faculty feedback supported this finding.

The feedback from students suggests that the just-in-time availability of concise and easy to understand information helped them explore their patients' cases more fully and in so doing, improved their learning. There wasn't enough direct feedback to suggest student confidence or satisfaction improved, but their enthusiasm during the focus group suggested they engaged with the technology and were looking forward to using the smartphones in their next course.

The initial selection and implementation of smartphones in a nursing course was successful and warrants further use. Issues of access suggest enough smartphones for all students in a class would be beneficial.

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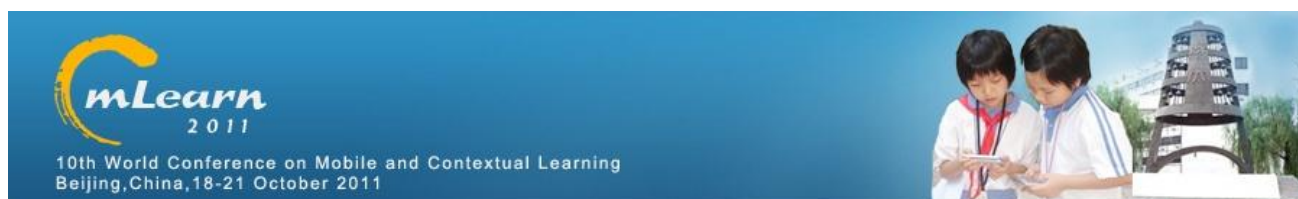
The use of mobile learning to develop understanding of biomedical sciences

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ABSTRACT

This paper presents evidence that 90sec video vignettes designed for delivery by way of mobile communication devices contribute to engaged learning and understanding of biomedical sciences as measured by higher student participation and attainment in physiology practical classes. By acting as a "just in time" prompt or "trigger" for learning, the vignettes situate students learning, bridge the link between lectures and practical classes, and provide a rationale for the relationship of the practical class to the etiology of various disease states.

Further, this paper introduces a new smartphone interface that allows access to existing scenario-based learning activities on the SBLi™ platform (www.sblinteractive.org). Leveraging student-owned technology for academic benefit, the SBLi™ smartphone interface offers high impact active learning opportunities away from formal teaching environments and at times that suit the learner.

Author Keywords

Interactive mobile learning; scenario-based mobile learning; biomedical sciences; emerging mobile technologies; SBLi; smartphone interface.

INTRODUCTION

This paper describes the increasing use of mobile learning in discipline-based scholarship of teaching and learning projects currently being implemented at The University of Queensland School of Biomedical Sciences to further understanding of biomedical sciences.

In 2010 the authors developed 90sec video vignettes of the laboratory classes for students to access via mobile phone technology or the Internet prior to laboratory sessions. We adopted O'Malley's definition of mobile learning as learning that occurs not at predetermined locations using mobile technologies (O'Malley, 2003). Using the vignettes to link lecture content to practical class, by literally illustrating the laboratory class activities and their relevance to future professional practice, our expectation was that students should be more engaged, leading to higher class participation rates, and higher levels of academic attainment as measured by final grades.

Over the past years our understanding of mlearning had changed: while the literature on mobile learning is both recent and modest, (Koszalka and Ntloedibe-Kuswani 2010: 151), the use of technology to aid teaching and to engage learners is as old as the invention of the stylus. There are multiple understandings and multiple meanings given to the term 'mobile learning', (Traxler 2007:4), and according to Wali, Winters, & Oliver (2008:42), "Many researchers rely on under-theorized conceptions of the topic, and those who have tried to refine the ideas involved have found this to be complex and difficult." We also were guilty in relying on "under-theorised conceptions" of mlearning, but now realise that mobile learning also "must view the learner as the one being mobile and not his/her devices! What needs to move with the learner is not the device, but his/her whole learning environment" (Laouris and Eteokleos, 2005).

The University of Queensland's interactive scenario-based learning platform (SBLi^TM) has a global uptake for scenario-based learning, and its effectiveness as a learning tool is well established (Breakey et al 2008; Gossman et al, 2007). Most recently, and based on Laouris and Eteokleo's (2005) definition of mlearning we designed and developed a scenario-based interactive touch screen application for hand-held devices: a prototype template of a new web-based SBLi^TM interface for smart phones. We chose an existing scenario, the Chronic Obstructive Pulmonary Disease (COPD) scenario, to test and evaluate the ease of usage and efficacy of this new smart phone interface on learning.

THE PROJECTS

Both projects were/are currently implemented at The University of Queensland School of Biomedical Sciences. Student internet access from their mobile devices via The University of Queensland Wifi is/was at no cost to the student. We also made the material accessible for standalone PCs, recognising that not all students have smartphone access.

The first project involved the creation of six video vignettes on osmosis, nerve and muscle, spirometry, blood pressure, ECG, and exercise. Each vignette was made available in first semester 2010 from a mobile phone-friendly website (http://www.uq.edu.au/sbms/mobile) which offered students a choice of viewing formats: iPhone, Flash and 3GPP. The cohorts involved were second year physiology classes conducted in first semester 2008 (n=286) and 2010 (n=320). The Physiology I course was taught concurrently to two distinct student cohorts: (1) Physiotherapy (PT) students and (2) Occupational Therapy (OT) and Speech Pathology (SP) students. Most students of both cohorts enrolled in a subsequent physiology course the following semester. Thus, comparison of course grade distributions of Physiology I courses of both cohorts (PT,OT & SP) in 2008 and 2010 to subsequent Physiology II courses of both cohorts in second semester 2008 and 2010 allow control for cohort variations between the years. Learning outcomes were quantified by course grade distribution for each year. For each year of the study new examination questions were written and marked by the same teaching staff member. The degree of difficulty of questions and the total number of marks allocated to the practical component remained the same. Self-reported student's personal mobile phone usage to access the internet and student's perception of the practical component of the course in regard to preparation, attendance and perceived relevance to their future profession was evaluated during lecture time in 2008 and 2010 by a paper-based student questionnaire with five point Likert-type scales. In addition, the 2010 questionnaire contained questions about student's utilisation of the video vignettes.

The second project introduced students to a new web-based SBLi^{TM} interface for smart phones to be used for the COPD scenario. The cohorts involved were again second year physiology classes conducted in first semester 2010 (n=320) and 2011 (n=204). Comparison of year on year summative assessment results for assessment tasks based on this SBLi^{TM} module (computer-based in 2010, smartphone-based in 2011), and comparison of 2011 assessment results between the SBLi^{TM} smartphone-based cohort and the SBLi^{TM} computer-based cohort allow evaluation of the efficacy of this new scenario-based interactive touch screen application for hand-held devices on learning. Self-reporting of student personal mobile phone internet access and usage of the material was evaluated in 2010 and 2011 by a student questionnaire with five point Likert-type scales. In addition student Internet traffic on both SBLi^{TM} versions were recorded in 2011.

RESULTS

In 2008 the average grade of the PT students in Physiology I on a scale of 1-7 (where 7 represents the highest achievable grade), was 5.01 with a standard deviation of 0.85. In contrast in 2010, the PT students achieved a significantly ($p<0.05$) higher average grade of 5.59 + 1.18. In Physiology II there was no significant difference in the grades achieved by PT students between 2008 and 2010. In 2008 the average grade of the OT and SP students was 4.69 + 1.00, while in 2010, the OT and SP students achieved a significantly ($p<0.05$) higher average grade of 4.99 + 1.08. In Physiology II there was no significant difference in the grades achieved by OT and SP students between 2008 and 2010.

In 2008 there were 207 respondents to the student survey; in 2010, 210. Both student cohorts reported a significantly lower absentee rate for practical class attendance in 2010. The SP and OT students reported that they were significantly better prepared for the practical classes in 2010, as well as being better prepared for a greater number of the practical classes, compared to 2008. All students reported significantly increased preparation times in 2010. Student perceptions of the relevance of the practical classes to their professions varied between cohorts and across years, but in 2010 the perception of relevance was increased after attendance at the practical classes in both cohorts. Of those students who responded to the student questionnaire in 2010 most accessed the videos via a computer (86%), while only a minority accessed the videos with their mobile phone (6%), and some others accessed the videos via computer and mobile phone (8%). Interestingly, there was no statistical difference in responses to the question "Do you have a mobile phone handset that is able to access the internet?" between the 2008 and 2010 cohorts. In both years about half of the students did not have a handset that was able to access the internet (51% in 2008, and 49% in 2010). Thus, in 2010, the question "How often do use your mobile phone to access the internet?" yielded the following response: more than half of all responding students (54%) never used their mobile to access the internet (*most of these students presumably did not have a handset capable of accessing the internet*), 12% of students used their mobile phone once a week to access the internet, 12% of students used their mobile phone once a day to access the internet, and only 23% used their mobile phone several times a day to access the internet.

At the writing of this paper the new SBLi[TM] smart phone interface project with the COPD scenario is currently in the implementation phase, and evidence of ease of usage and efficacy on learning will be presented at the mlearn 2011 conference.

OUTCOMES

Students who viewed the vignettes students attended more practical classes, and spent more time preparing for the classes that they did attend. These students also had significantly improved perceptions of the relevance of the practical classes to their respective professions, and this perception was enhanced after attendance at the classes. In addition, both student cohorts showed improved achievement of the learning outcomes as measured by course grade distribution. These observed differences between the 2008 and 2010 are unlikely to be due to cohorts differences over the years, given that an even grade distribution in the subsequent physiology courses in both years does not seem to support a great cohort variation. Similarly, questions used in summative assessment in both years were similar and assessed understanding of core physiological concepts, and neither teaching staff nor course content changed between the years. Thus improved learning outcomes in 2010 seem to be unlikely to be attributable to either cohort differences or course variations.

Only about 50% of surveyed students reported owning an Internet enabled smartphone and very few surveyed students accessed the videos from their mobile phones. The surveys were paper-based and conducted during lecture time. Students who utilize mobile learning technologies may in fact be students who find it hard to adhere to time and location constrains and thus not been present for the paper-based surveys. Therefore it could be argued that the actual number of students that used mobile devices to access the videos might be higher than the reported percentage of surveyed students. Further, it is arguable that both iterations (2008 and 2010) have occurred before the use of mobile devices in higher education reached the tipping point of ubiquity. Both the academic literature and industry forecasting report increasing penetration rates of smartphones among the demographic studied here.

CONCLUSIONS

We know from the Delphi-type research of the New Media Consortium of the currency of mobile devices in higher education learning environments (Johnson 2010: 12ff). Implicit in the two projects discussed here has been an iterative approach to the development of mobile learning driven by our changing understanding of the nature of mobile learning. Our approach to each successive project has been informed by the increasing volume of academic literature, by both the measurable outcomes and our own reflections on our teaching practice (Shon 2003), and also by the release of new platforms, applications and devices.

The mobile accessible video vignettes act as a "just in time" prompt or "trigger" for learning, and situate students learning, bridging the link between lectures and practical classes, and provide a rationale for the relationship of the practical class to the etiology of various disease states. This is consistent with the long established findings of Boud and Pearson (1979). The significance of the second project lies in the attempt to create a discipline specific interactive mobile learning interface that allows the learner to approach clinical scenarios via multiple decision making pathways. Thus, the SBLi[TM] smart phone interface aims to promote deep learning through consolidated understanding and application of physiology, anatomy and pharmacology.

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A Critical Analysis of Post-Secondary Distance Education in the United States: Past and Present

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ABSTRACT

Research focusing on distance education, which represents an important aspect within the broader field of mobile learning, has grown tremendously in recent years. While considerable focus has centered on the role of technological innovations and the proliferation of internet-based educational programs, there exists a significant gap in this body of research, particularly with regards to studies that take a critical perspective on mobile learning. Moreover, scant attention has been paid to historical considerations that parallel many recent developments and which might better inform current debates related to distance education/mobile learning. This paper works to address both of these two concerns. First, this paper provides a brief overview and critical analysis of the rapid growth of online distance education programs among for-profit colleges and universities in the United States. Second, this paper links these concerns to historical examples of distance education by examining the rise of correspondence schools and programs in the United States roughly a century ago. This study is particularly timely and significant given the large numbers of students now enrolled in online programs at for-profit colleges and universities and the aggressive marketing to key educational entrepreneurs throughout the world.

Author Keywords

online education, distance education, for-profit education, critical analysis, historical analysis, mobile learning, proprietary schools

INTRODUCTION

Research interest in distance education, which represents an important aspect within the broader field of mobile learning, has grown tremendously in recent years (Ally, 2009; Moore & Anderson, 2003; 2007). While considerable focus has centered on the role of technological innovations and the proliferation of internet-based educational programs (Rudestam & Schoenholtz-Read, 2002; 2010), there exists a significant gap in this body of research, particularly with regards to studies that take a critical perspective on mobile learning. Moreover, scant attention has been paid to historical considerations that parallel many recent developments and which might better inform current debates related to distance education/mobile learning.

This paper works to address both of these two concerns. First, this paper provides a brief overview and critical analysis of the rapid growth of online distance education programs among for-profit colleges and universities in the United States. Second, this paper links these concerns to historical examples of distance education by examining the rise of correspondence schools and programs in the United States roughly a century ago.

Only a small handful of studies have critically examined the growth and practices of for-profit colleges and universities. The most profitable for-profits enroll the overwhelming majority of their students in online distance education courses. This study is particularly timely and significant given the large numbers of students now enrolled in online programs at for-profit colleges and universities, the levels of growth anticipated at these institutions in years to come, and the fact that this model of post-secondary education is now being aggressively marketed to key educational entrepreneurs throughout the world.

CONTEMPORARY POST-SECONDARY DISTANCE EDUCATION

Currently, the fourteen publically traded for-profit colleges and universities in the United States enroll 1.4 million

students. The largest of these schools is the University of Phoenix, a subsidiary of the Apollo Group. The University of Phoenix offers a wide array of online courses and degree programs. It currently enrolls roughly half a million students, making it the largest university in the United States and one of the ten largest universities in the world.

Much of the growth among for-profit colleges and universities in the United States has been made possible by the ability of people to enroll in programs that deliver course content online via the internet. Rather than being bounded to a specific place – such as a building on a university campus – students are afforded a greater degree of flexibility with regards to their education. As a result, students attending online for-profits are more likely than their "traditional student" counterparts, who attend non-profit or public colleges and universities, to be people of color, to come from low-income families, to be first generation college students, to have children of their own, and to hold full-time employment throughout the duration of their education.

The flexibility of mobile learning at the post-secondary level has not only enabled people historically denied access to college/university education the opportunity to complete a degree program, but it has also contributed to enormous levels of growth at for-profit colleges and universities: a 236% increase in enrollment in the US over the ten year period of 1998 to 2008. This growth was also made possible as a result of the greater availability and expansion of federal student aid programs.

With the passage of the Deficit and Reduction Act of 2005, legislation capping enrollment in online distance education programs was eliminated. This removed the "50%" or "50/50" rule, which barred all colleges and universities from enrolling more than half of their students in online courses. No longer faced with enrollment caps, for-profits eagerly and aggressively expanded their online programs. Of particular interest for recruitment were students qualifying for Pell Grants (need-based governmental subsidies for post-secondary education) and Stafford Loans (federally-backed, low-interest loans) – funds which go directly to the college or university. At stake are enormous sums of money. In 2009 alone, $26 billion in US federal, taxpayer money was funneled into the for-profit higher education sector in the form of student aid.

Problematically, the increased availability of student aid for under-represented student populations has led to the overly-aggressive recruitment of students from historically marginalized backgrounds by for-profit colleges and universities for enrollment in their online distance education programs. For-profit colleges and universities account for 12% of all college enrollments in the United States, yet they receive 24% – a disproportionally larger share – of all federal student aid. While increased access to post-secondary education is important given that an advanced degree will significantly raise a person's lifetime earnings potential, there are some serious concerns over the efficacy of these types of for-profit distance education programs.

Over the past year, the United States Senate Health Education Labor and Pensions Committee conducted a series of hearings investigating the practices of for-profit colleges and universities, which enroll the majority of their students in online distance education programs. Of particularly notable concern were: deceptive recruitment practices, excessive student debt loads, doubts about the fulfillment gainful employment rules, and the considerably higher default rates on loans among students who had attended for-profits. In other words, for-profit colleges and universities are using online distance education programs to exploit the already disadvantaged – offering the hope of having the benefits of a college degree yet failing to deliver on that promise.

In spite of these concerns, many traditional "brick and mortar" colleges and universities have begun to perceive the for-profit sector's online degree programs as a threat. Fearing that they are losing students to these programs, some have created their own online degree programs. Others now offer blended/hybrid courses that combine aspects of traditional classroom-based instruction with online coursework. Critics charge that these forays into online distance education represent little more than a "cash cow" for colleges and universities.

HISTORICAL POST-SECONDARY DISTANCE EDUCATION

With these points in mind, it is perhaps instructive to draw parallels to issues connected to mobile learning that arose roughly a century ago. It should go without saying that while conditions impacting mobile learning in the United States and throughout the world are different now than they were one hundred years ago – economies are different, technology has changed, education attainment levels are greater, etc. However, the presence of distance education programs within the field of post-secondary education is not a new phenomenon.

It is widely recognized that technology is an important part of mobile learning. The development of the Internet and related computer technologies has been the key to the rapid expansion of online distance education programs in recent years. Somewhat similarly, the growth of correspondence schools in the early 20th century was also facilitated by technological innovation. In the case of correspondence schools, the establishment of a cross-continental railway system enabled faster and more reliable postal service to be established in the United States. In both instances, the development of technologies allowed for the growth of different, yet strikingly similar, forms of mobile learning to occur.

In 1890 International Correspondence Schools (ICS), a for-profit company offering distance education programs, was founded in London, England. In 1901, ICS opened a branch in the United States – it is still in existence today; although its name has been changed to Penn Foster College and it has since been acquired by Princeton Review, a standardized test-preparation and consulting company. At the time of its founding, ICS was the only correspondence school in the United States. However, within a few short years, ICS was joined by numerous other for-profit institutions actively competing to enroll students, the largest of which were ICS, LaSalle Extension University, Alexander Hamilton, the American School, the Federal Schools, and the National Radio Institute. "By 1926 there were over three hundred such schools in the United States, with an annual income of over $70 million (one and a half times the income of all colleges and universities combined), with fifty new schools being started each year" (Noble, p. 6).

Noffsinger (1926), the author of one of the studies on adult education commissioned by the Carnegie Corporation, claimed that in 1924 "four times as many persons were studying by correspondence with privately owned schools as there were in all the resident colleges, universities and professional schools combined" (p. 16). However, only a tiny portion of students who enrolled in correspondence education courses remained until completion. And with only 5% to 15% of students finishing year long courses (Hampel, 2010), profitability depended largely upon the extent to which dropouts continued to pay for courses that they were no longer taking. As a result, contracts between students and correspondence schools – particularly those denying students the ability to receive a refund after discontinuing their studies – were of critical importance to the ongoing operation of for-profits and home study departments within traditional colleges and universities.

As with their contemporary counterparts, correspondence schools received sharp criticism from the public and from various stakeholders. Critics charged that correspondence schools aggressively recruited students and targeted particular demographic groups more heavily – paying large teams of salespeople a commission-based salary determined by the number of students a person was able to enroll. Students enrolled in correspondence courses were met with high tuition costs and uncertain outcomes for actual career advancement. Many correspondence schools were likened to diploma mills and reportedly offered students an education that prioritized profit-generation over quality.

Perceiving a growing sense of competition from the for-profit sector, traditional colleges and universities also began to develop their own correspondence education programs. Beginning first at the University of Chicago's Home Study Department, other universities quickly thereafter sought to start their own similar programs. Of the state universities offering correspondence education programs, the University of Wisconsin-Madison and the University of California-Berkeley soon grew to be the largest. Columbia University, a relative latecomer to the field, quickly became the largest and most profitable – growing from an enrollment of 156 students in 1920 to roughly 10,000 by 1929 (Noble, 2001), a number which represented 13% of all home study students in the United States at the time. Flexner, who is probably most well known for his (1910) critique of medical education in the US, stated of correspondence education that "the whole thing is business, not education" (Flexner, 1930 p. 144).

CONCLUSIONS

In conclusion, it is important that current discussions of mobile learning not remain primarily focused on current practices and/or new technological innovations. As this paper attempts to illustrate – by juxtaposing recent concerns over the practices of for-profit colleges and universities, which enroll the majority of their students in online distance education programs, with the concerns raised roughly a century ago over the practices of correspondence schools – there is a need to contextualize ongoing developments related to the advancement of certain forms of mobile learning through historical analyses. This paper addresses gaps in existing research by critically examining the recent growth of for-profit colleges and universities in the United States and by linking current concerns to largely parallel historical considerations.

Lastly, given the anticipated levels of growth among for-profit colleges and universities and current financial investor fervor, the US market will likely become over-saturated with providers in coming years, precipitating further expansion into international markets. Already, US companies focused at the K-12 level, such as Edison inc., have established themselves internationally. Rapidly developing economies in countries such as China, in this context, will most likely be viewed as an educational "greenfield" – an economic term used to denote a previously undeveloped site ripe for commercial development. Consequently, the types of concerns addressed in this paper should not go unnoticed. Ultimately, while mobile learning has helped to expand educational opportunities for a greater number of people from increasingly diverse backgrounds, such growth should be welcomed cautiously. There continues to remain a vast array of unknowns and an ongoing need for further research.

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Researching emergent practice among mobile language learners

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ABSTRACT

Within the phenomenon of widespread adoption of mobile technologies to support informal and personally relevant learning, we seek to identify instances of innovation where emergent practices point to productive ways of learning that in the longer term may also have an impact on formal education. The paper reports our ongoing research focusing on language learners, for whom mobile devices represent a liberating technology that prompts them to rethink and redefine their foreign language learning. Building on the outcomes of 30 interviews with language learners using mobile devices, we share findings from our continued exploration of emergent practice, and include two contrasting case studies of independent learners of Japanese and Chinese. Our findings lead to reflections on authenticity in language learning and we note the strong motivations that lead learners to explore ways of learning that truly correspond to their personal preferences and needs. The research is a contribution to mapping the territory of informal mobile language learning, as we continue to investigate the mobile-enabled resources available to language learners and the strategies they adopt for learning.

Author Keywords

Language learning, self-directed learning, mobile-assisted language learning, ecologies of resources

INTRODUCTION

Mobile devices have become integrated with daily lives through the process of domestication (Ling &Donner, 2009). Increasingly, educational provision must recognize that since the devices are a significant part of the grain of daily life, it means that they will be used for information access and learning, even if only informally. The ubiquity of mobile and wireless technologies suggests that patterns of use developed through informal learning will also have an impact on formal education through learners' growing expectation of mobile access. Uncovering emerging patterns of use, and trying to work with them rather than against them, is the current challenge (Pettit & Kukulska-Hulme, 2007).

Among foreign language learners, there is a long tradition of self-access to learning materials (e.g. Gardner & Miller, 1994) and the pursuit of language learning as a lifelong interest linked to transformation of personal identity, with strong social and informal elements that may complement formal courses of study. Semi-structured yet informal language learning is a rapidly growing enterprise, with environments such as Busuu.com providing a virtual space for individuals, communities and resources, with mobile access to language activities offering additional everyday practice. Yet for many learners, the opportunity to use their personal mobile device to support an aspect of language learning is the starting point for an individual journey towards satisfying particular personal requirements with regard to content, type of practice needed or the circumstances of a person's work and life. Our research is focused on these individuals who are forging ahead with developing their own ways of learning, using mobile devices and whatever materials, resources and human connections they decide are helpful, in the course of building their ecology of resources for learning (see also Luckin, 2010; Underwood, Luckin & Winters 2010). We seek to uncover emerging practices, assess in what ways the activity is innovative and examine the implications for next generation designs for mobile language learning.

INTERVIEWS WITH LANGUAGE LEARNERS

Thirty adult learners (17 male and 13 female) of twelve different languages (Japanese, Spanish, French, Euskara, Irish, English, Chinese, German, Welsh, Italian, Russian and Indonesian) volunteered to be interviewed about their use of mobile devices to support their informal language learning. Interviews were semi-structured and aimed at exploring how a variety of mobile devices –smartphones, mp3 players, handheld game consoles, digital cameras– helped our subjects acquire a foreign language; specifically we sought to find out concrete examples of how these devices were used, establish patterns and common scenarios of practice, and understand the motives for

adoption from the personal perspective of each of our interviewees. The 2 cases we present here will serve as illustrations of our findings to date.

Case X – learner of Japanese – exemplifies an individual who is painfully aware of his early failed attempts at learning a foreign language; he knows that if he is to learn a language, he has to do it in a different way, by choosing his own goal (to be able to read in Japanese) and choosing his own method (memorize flashcards). The mobile device provides him with a means to realize his goal. "I'm not someone that found languages terribly easy at school", he tells us; as an adult, after an unrewarding attempt at learning Spanish, he is now focusing on Japanese, partly because of a previous stay in Japan, and partly because language learning "feels a bit like unfinished business". Remarkably, he talks about learning a language in terms of "producers" and "consumers", and thus differs from most of his peers in that instead of striving to speak fluently, his motivation is "being able to read something and to consume some things that I find interesting in Japanese". To this purpose he has bought a mobile phone and installed software that runs flashcards in kanji, and aims at clearing a certain number of cards every day. Like so many of our interviewees, he finds the portability of the device very appealing –"I deliberately bought the [mobile phone] because it was fun, it was a cool little device, (…) and I was really pleased because all of a sudden, it really was *wow, this is in my pocket!*". Since it is in his pocket and with him all the time, taking out the device to learn a few cards becomes an action that does not discriminate time or place, a combination of routine and spontaneous use which we have come to establish is popular with the majority of our mobile language learners –"I will normally do [some cards] at breakfast, I'll often do them last thing at night in bed, I'll do them watching the World Cup (…) I've probably done them waiting in a queue several times." In this regard, mobile devices facilitate learning at moments otherwise considered "dead time" –e.g. commuting to work, waiting for an appointment, going for a walk– but this better use of time comes equally from a belief that it is the individual's choice to learn a language this way, that learning a language informally with a mobile device does not represent a chore that will give cause for concern and regret if missed –"I think [the device] makes [learning a language] a lot easier; you don't have to, so even if I'm not doing anything else, at least I know that I've not stopped (…) I guess for a lot of other people it's that kind of, you haven't done it for four days and you do a bit and it's really hard work, (…) whereas I am making a choice to do this."

Case Y – learner of Chinese – is a more successful and experienced language learner, who has studied several languages formally in a classroom situation and has lived abroad in several countries. He is also a language teacher who blogs about his experience of language learning and has an awareness of his own development as a learner: "I found as I get better at language learning I'm getting more confident with myself and knowing what I want and how to learn". He tells us how he went about learning Chinese with an mp3 player and a digital camera during a recent stay in China: "I've been recording conversations I've had with people in Chinese, in my very basic Chinese. So for example, I would record the conversation buying soya milk and asking them how they make their soya milk, *'What is that?', 'Oh it's sugar'.*" These recordings become key learning objects as he plays them back in one-to-one sessions with a teacher, learns to write and pronounce the words, and gains confidence to use them outside the classroom. There is a strong sense of personal satisfaction: "It felt really good. It felt a lot of fun and felt like I was really interacting with my language. And it was very, very different from passively listening to a radio station, which of course I couldn't do in Chinese". He takes photos of what he finds peculiar, to talk about it in class: "…in China they have these, I guess they're sort of police boxes, but they're kind of like signs that just flash and says "Police" and there's a telephone number. And so I wanted to know what is it, why is it? You know. Very strange thing and so I took a photo of that. And so things like that, I think, you know "*What's going on here*?" and then bring it into class and have a conversation about it. And then there'd be new words that come out of it but it would also be me repeating a whole load of phrases that I'd, you know, learned before." He is aware of his own limitations as a beginner language learner, but that does not stop him from looking to do things differently, looking for fun, wanting to be active, and finding that a mobile device is a channel for authentic interaction. He explains how he also takes snaps of signs, billboards, menus –"I would look at a menu and go blank. But through bringing them into class I was able to learn words like *steamed dumpling* or something like that, that would appear frequently and so I'd be able to recognise those and build up vocabulary around that: *'Is that pork or vegetable?'*. The effect of the mobile device on his learning is that it brings a connection to the real world; through the mobile device he is able to bring authenticity into his lessons –"I really enjoyed that, really having a connection with the things around me". He remarks that his mp3 player is unobtrusive, and because people around him do not notice it, he has been able to put it next to something else that he is holding, and make a recording.

RELEVANCE AND LIMITATIONS

The two cases above show contrasting approaches to learning a language, which doubtless reflect in some way the learners' circumstances in terms of being either outside the target language country or travelling within it. Our sample of informal learners do not tend to study in a group, which is not to say that they are isolated; on the contrary, mobile devices provide a connection to a level of peer support that learners find both motivating and customizable. In the following quote, the learner of Japanese refers to the online forums where he lurks fishing for tips to learn kanji –"It's one of the first times that I've seen the real value of the sort of peer support (…) all of a

sudden you find something, you're interested enough and there are all these people posting their experiences and it is quite motivational; it gives you ideas, because I think you stagnate if you just do the same thing." The learner of Chinese finds it motivating to have animated discussions with his teacher, using the artifacts and recordings he has gathered on his daily rambles in China. But his motivation also comes from having discovered a learning method that he is personally very satisfied with, which contrasts with his previous experience: "(I can tell you about) textbooks that I've used, particularly with Chinese, where they've just missed the point entirely and not teaching the stuff that I want to learn".

In language teaching, it is still considered that use of authentic learning materials, i.e. typically written or spoken by native speakers for non-language teaching reasons, is an excellent way to approximate an authentic communication experience. But as Duda and Tyne (2010) have observed, technology can turn on its head the idea that "authenticity in materials is essentially about the conditions in which they are produced …" to arrive at the idea that "authenticity can also be about the conditions in which they are used … or indeed the conditions in which they are created" (p.100). In this way, the essential goal of authentic communication is transformed from an aspiration to a situated enactment. However, the personally meaningful learning that we are discovering through the case studies is being done outside of formal education, and it will be challenging to find ways of integrating these positive informal experiences with formal learning.

MAPPING THE TERRITORY OF INFORMAL MOBILE LANGUAGE LEARNING

Following on from the interviews, we have continued to investigate the mobile-enabled resources available to language learners and the strategies they adopt for learning. Developments include access to an abundance of mobile apps through iTunes and other online stores, increasing opportunities for mobile social networking, and mobile interaction with online environments that were once desk-bound. Learner strategies are in line with those identified as belonging to successful language learners more generally, such as practising; repetition; self-monitoring, etc. (Bond, n.d.), yet mobile technologies can both restrict the range of strategies available (such as limitations on visual mnemonics) and introduce new ones, e.g. drawing on more diverse social networks and aligning language practice with the small routines and unexpected opportunities of everyday life. At one end of the innovation scale, mobile learners exhibit conventional language learning behaviours like memorizing vocabulary, while at the other end, they create their own agendas, networks, resources and tools. As noted by Norton and Toohey (2001), interest in successful activities or practices in second language acquisition has had a long history; yet defining what makes a successful language learner requires constant updating, as the language learning landscape continues to evolve (Young, 2009).

CONCLUSIONS

Emergent practices point to personal, productive ways of learning that in the longer term may also have an impact on formal education. Our interviews provide evidence that mobile technologies facilitate and encourage self-directed learning, and they bring to light previously hidden learner motivations connected to mobility and personal use of time. It is also clear from this research that other learners, who have limited experience using mobile devices for language study, will benefit from guidance on how to make the most of everyday, situated opportunities for learning. In terms of preferred technologies and their relationship to emergent practices, it appears that currently learners are using whatever mobile device they happen to own, and when they hit upon something that works for them, they stay with it. More widespread sharing of both successful and unsuccessful learning is necessary to bring the hidden, personal experience of individual learners out into a public forum where learners, teachers and mobile technology designers can all learn from it.

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EDUCATE on SITE: User Acceptance of Mobile Web Applications in Architectural Education

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ABSTRACT

The mission of the EDUCATE project (EDUCATE, 2011) is to improve the integration of sustainability and energy efficiency in architectural curricula in Europe. For this purpose, seven European universities each with different expertise and expert knowledge in the field of sustainability in architectural design founded a consortium. In order to exchange knowledge between the partner universities in the consortium, a web Portal, the EDUCATE Portal, has been developed.

The relatively high screen resolution, powerful processing units and fast Internet connectivity of modern mobile devices means that the functionalities of the EDUCATE Portal can be made available on these devices. More and more web sites are introducing either mobile versions of their site or special applications to access their web site via mobile devices such as a mobile phone or a pad.

In this paper, we investigate current user acceptance towards a mobile device service for the EDUCATE Portal using a questionnaire and present interim results. We also describe a prototype, EDUCATE on SITE, which allows users to connect to mobile services of the EDUCATE Portal. The prototype will be used in a pilot study to investigate changes in user behaviour and evaluate acceptance of the Portal mobile services.

Author Keywords

EDUCATE, Web Service, location based, students mobile web acceptance

INTRODUCTION

To address changes in the design of the built environment, the mission of EDUCATE is to remove pedagogical barriers to the integration of sustainability and energy efficiency in university curricula and in the practice of architecture, disseminate know-how and exemplars of best practice in environmental design, and propose the harmonisation of qualifications across Europe (EDUCATE, 2011). In order to support this process a web Portal has been designed which is accessible by the partner institutions and their students to support both lecturers and students in teaching and learning.

The EDUCATE Portal offers a range of different functionalities to users. In this paper, we focus on a subset of the Portal functionality relevant to mobile devices. The EDUCATE *Knowledge Base* (KB) represents the collected expertise of the seven consortium members of key concepts in sustainable architectural design. The KB is organised into three main parts: *Issues and Principles, Applications and Case Studies* and *Tools*. The information contained in the KB is organised into *categories*. Each category contains clusters of *topics* that are further broken down into aspects or *'tabs'*. In order to help students find information concerning a specific lecture or topic, a lecturer can create a *reading list* consisting of an ordered, annotated set of links to the KB. Students and lecturers are able to discuss different topics in *forums*. Additionally students can *Ask Question* about a specific KB topic in private, which will be answered by an appropriate expert from within the consortium. Experts can make (anonymised) answers to frequently asked questions publicly available through the *Knowledge Base FAQ*.

The EDUCATE Portal was originally intended for use in the design studio. However, more and more students are starting to use their mobile devices to access web sites like Facebook and Twitter on the move. The aim of EDUCATE on SITE is to explore whether users will access the EDUCATE Portal in a similar way and how such access can be supported. The ability to access content on the move via a mobile device makes it possible to combine cognitive learning and experience in-situ. Students can experience real world examples of the buildings and techniques described in the KB and are able to access all the relevant information from the KB on site. Any questions can be asked and/or discussed directly on site and the fact that most modern mobile devices are equipped with a camera makes it possible to attach photos to the questions.

QUESTIONNAIRE

To establish users' preferences regarding which services of the Portal should be available on mobile devices and to recruit users for the pilot study, a questionnaire (Questionnaire, 2011) was created. A request to complete the questionnaire was sent to all EDUCATE Portal users (currently 1000+). However, due to the term dates of the different universities (Belgium, Germany, Hungary, Italy, Spain, UK), only some students, lecturers and professionals have responded to the questionnaire, as such questionnaires are filled out typically at the end of a term. The questionnaire is therefore still open, and the results presented here are based on responses from 27% (312) of the Portal users, mainly located in the UK and Italy.

More than the half of the users (60%) regularly access the Internet using their mobile device. The most commonly used application is Google search/maps (77%) followed by Facebook (59%) while fewer (36%) are using Twitter. Almost two-thirds (62%) stated they would use a mobile application to connect to the Portal if available. According to the users' responses, the most important functionality of the Portal that should be made available on mobile devices is the *KB* (80%), followed by the *Ask a Question* (75%) and the *Knowledge Base FAQ* (73%) functionality. The *forum* functionality was seen a less important (69%), perhaps because it involves more typing on the mobile device. However, the demand is still high enough to include this functionality in the test.

PROTOTYPE IMPLEMENTATION

In parallel to the questionnaire, we evaluated which parts of the Portal could be made accessible to mobile devices and the most appropriate approach to visualise the data on a mobile device. In addition to the currently available services, the introduction of a new location based service was also explored.

There are two principal methods that could be used to implement EDUCATE on SITE:

1. Using a special theme optimised for mobile devices to display the content. To be able to use this approach, the CMS has to support multiple themes and a method to automatically switch a theme depending on the capabilities of the connected client (identify mobile device web browser).

2. Using an application on the mobile device to display the content from the web site. To be able to use this approach the CMS should support a way to retrieve the raw content, therefore the CMS has to offer any way to support a Web Service.

The EDUCATE Portal uses a CMS called Drupal (Drupal, 2011) and the first method can be implemented using existing Drupal modules. For example, to identify the user's browser type, the following modules can be used: *Browscap*, *WURFL*, *Mobile Plugin*, or *Mobile Tools* (can be used with Browscap and/or WURFL). With the help of one of these modules, the following modules can be used to switch the theme: *Mobile theme*, *Switchtheme* or *Mobile*.

In order to implement the second approach, the application on the mobile device has to receive the data from the portal. This is in usually achieved by the use of a so called Web Service. The three most commonly used once are: Simple Object Access Protocol, SOAP (SOAP, 2011), Remote Procedure Call, RPC and Representational state transfer, REST (Rodriguez, 2008).

APPROACH SELECTION

In order to select the best approach to present the data on a mobile device screen one has to take the constraints of mobile devices as well as the constraints of the CMS into account (Mobile Web Best Practices 1.0, 2008), (W3C Mobile Web Initiative, 2011), (Drupal, 2011).

One of the biggest constraints of mobile devices besides connectivity is their screen size and resolution. This is particularly true for mobile phones, which typically have small, low resolution screens. As a result, content must be optimised. Although it is possible to optimise the content for a mobile device browser, in many cases some screen space is wasted. The reason for this is that a mobile web site must contain navigation elements that are difficult to hide, as well as the browser navigation elements.

Another problem with most CMS is that images are not optimised on the fly for a mobile device. A standard way to adapt images for mobile phone screens is to adjust them via CSS (client side scaling); however transferring the high resolution images requires more bandwidth and can increase costs for end users.

These problems can be solved by the use of an application. However an application depends on the mobile device operating system. Therefore it is necessary to develop such an application for every mobile device operating system. In order to improve apparent connectivity content has to be cached at the client side. This way already accessed content does not have to be downloaded which saves bandwidth and speeds up the loading time. An application can generate and maintain local cached data, which is not possible with a mobile device's browser. As a result it was decided to use an application to visualise the data on the mobile device. Deciding which technical approach of a Web Service implementation to use was simpler because the XML-RPC is built into the CMS; in contrast REST was still in beta when the project began.

THE APPLICATION

After launching the EDUCATE on SITE application, the user sees the start screen (Figure 1), where they can choose which service to use. The upper image of Figure 2 shows a traditional service, the forum, with two replies. The user is able to see the more detailed presentation of the question/reply by touching the corresponding summary in the list. The lower image (Figure 2) shows a KB topic with five tabs. Figure 3 shows a new service called SITE-map which is described in the next section.
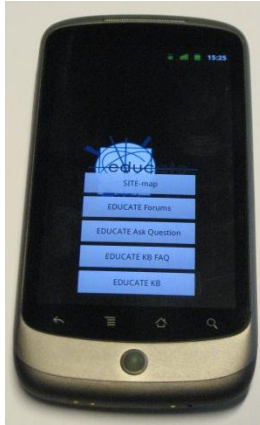
| Figure 1: Start screen of application | Figure 2: Forum and KB | Figure 3: SITE-map |
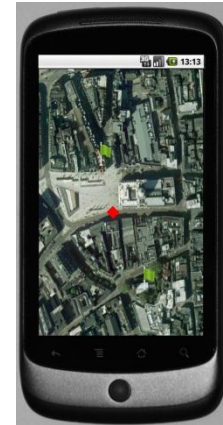
The availability of Google maps in combination with the availability of the user's position led to the idea of a location based service. The SITE service therefore uses a Google map to overlay the user's position and interesting buildings from the EDUCATE KB close to the user's position. A user can use the SITE service to: search for a design example close to her/his actual position, find an example building "in the real world", receive notifications when a example building of interest is close to his position, and upload a photo of a building and ask a lecturer/tutor if the building fits or violates a special design guideline. SITE-map leverages the advantages of mobile devices, namely: always on, no need to power them up, most users always carry a mobile phone/device with them and newer devices are aware of the user's position (geo location).

The pilot test is still ongoing, and the results of the data analysis and the results of a post questionnaire will be available at http://www.educate-sustainability.eu/educate-on-site/pilot-study

CONCLUSION AND FURTHER DEVELOPMENT

Following the pilot study, we plan to further investigate usage and acceptance of the mobile device services of the EDUCATE Portal. To evaluate acceptance, we will use access statistics and a comparison of the results of pre- and post-test questionnaires. Because the pilot study is conducted in six European countries, it will be interesting to investigate whether the cultural background has an influence on the acceptance and usage of the traditional and the new, location-based service. The prototype application runs on Android-based mobile devices. Although the market share of Android based devices is increasing, currently users of other mobile phone operating systems are excluded. Therefore the next step will be the investigation of the use of the Titanium SDK which makes it possible to generate an iOS app (for iPhone and iPad) in addition to our existing Android app.

ACKNOWLEDGEMENTS

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Comparison between Mobile and Ubiquitous Learning from the Perspective of Human-Computer Interaction

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ABSTRACT

In accurately defining mobile and ubiquitous learning approaches, it is not sufficient simply to consider the availability of resources for learning, or the ease with which mobile learners acquire information. This limited consideration could play a role in blending both learning approaches as they assist the mobile learner. This paper will examine the nature of interactions between learners and mobile devices, in order to draw a comparison of mobile and ubiquitous learning approaches. This comparison leads to better understanding of their potentials and the differences between their environments.

Author Keywords

Mobile learning, m-learning, ubiquitous learning,u-learning, pervasive learning, p-learning, eHCI, iHCI, ubiquitous computing.

INTRODUCTION

The swift pace of development in mobile technologies and wireless communication infrastructure has had significant impact on   the lifestyles of most people. The combination of modern mobile technologies and network services allows interaction between individuals in spite of geographical constraints, and has fundamentally affected the way people now communicate. A wide variety of data, from simple text to intensive multimedia streams can now be retrieved and managed using hand-held devices. The increasing popularity of these devices has encouraged learning using mobile technology, widely known as mobile learning, or m-learning. It has also encouraged the implementation of ubiquitous computing in education, for example, to provide context-aware educational applications. These are widely referred to as ubiquitous learning (u-learning), or pervasive learning (p-learning). Exceptional growth in the number of mobile users, with five billion subscriptions now estimated worldwide (ITU, 2010), has generated significant interest in the potential of mobile technology for learning enhancements. Although the literature suggests a number of definitions for the concept of u-learning, there is no consensus of opinion, potentially due to the subjective approaches adopted by different researchers regarding its perception and characterisation (Hwang, Tsai, & Yang, 2008). Both u-learning and m-learning represent distinct approaches in which various technologies can be used to enhance the delivery of learning resources. Both approaches involve utilisation of similar mobile technology to fulfil various purposes, such as the presentation of learning material to users; however there are differences in specific methodology between them. Comparing m-learning with u-learning from the perspective of mobility or availability of learning materials is complex, and may lead to misconceptions and misunderstandings of their original ideas. There is consequently little existing research concerning the differences between m-learning and u-learning, specifically with respect to how learners interact with mobile technology in such environments.

In accordance with such a need, this paper will attempt to consider the nature of interactions between the learner and relevant technology in order to draw comparisons between m-learning and u-learning. The differences between these environments will thus be elucidated, along with a clarification of the nature of interactions between learners and mobile devices in each environment. Such comparison will serve to highlight the potential of the two learning approaches. Section 2 briefly clarifies the concept of ubiquitous computing. Section 3 highlights the difference between explicit Human-Computer Interaction (eHCI) and implicit Human-Computer

Interaction (iHCI), and addresses the suitability of iHCI for ubiquitous computing. Section 4 discusses the difference between m-learning and u-learning.

CONCEPT OF UBIQUITOUS COMPUTING

The concept of ubiquitous computing was originally introduced by Weiser (1991) as "the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it ". He clearly describes ubiquitous computing as a phenomenon that takes into account the natural human environment and allows the computer itself to fade into the background (Dey and Häkkilä, 2008). Moreover, his vision refers to the collaborative or collective use of computer devices that might be embedded in a specific predetermined physical environment, thereby allowing users to interact invisibly with them. The main aim of this idea is to create an environment in which the connectivity of devices is embedded in such a way that it is unobtrusive and always available. Weiser's vision involves introducing computers into people's lives, that is, putting computers into a daily living environment instead of representing the everyday environment in the computer (Loke, 2006). When computing becomes ubiquitous, learning may become more active and in context. Also, the direct interaction between the learners and computers is improved by helping the learners focus more on the task itself rather than on how the task is performed.

EXPLICIT VERSUS IMPLICIT HUMAN-COMPUTER INTERACTION

In the field of education, the nature of interaction between the learner and the computer must be carefully considered. This is essential to ensure the interaction is effective in order to achieve the intended learning objectives of the implemented applications. Understanding the difference between these two modes of interaction, eHCI and iHCI , is important as it plays a crucial role in achieving a level where the difference between m-learning and u-learning is fully realised and understood.

eHCI

eHCI is the ordinary type of human-computer interaction. This type of interaction involves a high level of human intervention. Explicit HCI "puts the user at the centre of the interactive systems, so that the control of the system responds to and is driven externally by the user, rather than the system being driven internally" (Poslad, 2009). In this interaction, the operation of the computer system is influenced by the users' activities. Users explicitly communicate with computers in different ways, based on a specific level of abstraction (command line, direct interaction using GUI, speech input and gestures, etc.). This conveys to the computer their expectations and needs. In this case, the computer has to be provided with more detail by the users in order to operate effectively.

iHCI

This type of interaction is more intelligent than the eHCI as the users are not expected to provide the computer explicitly with the all needed entries to operate. This is different from the traditional iHCI; it is a new way of operating that allows the computer to come closer to being able to perform naturally with humans, as people do among themselves. The iHCI is defined as "an action, performed by the user that is not primarily aimed to interact with a computerised system but which such a system understands as input" (Schmidt, 2000). Further details about this concept are that it is "the interaction of a human with the environment and with artifacts which is aimed at accomplishing a goal. Within this process the system acquires implicit input from the user and may present implicit output to the user" (Schmidt, 2005). Accordingly, the "implicit input are actions and behaviour of humans, which are done to achieve a goal and are not primarily regarded as interaction with a computer, but captured, recognised and interpreted by a computer system as input" (Schmidt, 2005). He continues to define the implicit output as the "output of a computer that is not directly related to an explicit input and which is seamlessly integrated with the environment and the task of the user". The iHCI makes use of many sensing technologies to determine the current context of the monitored environment, objects or entities. This sensed contextual information is considered as an implicit input to facilitate and support the implementation of such intelligent interaction. An example of iHCI is the automatic light control (where the light is switched off when the sensors do not detect any movement in the room); another example is the intelligent identification card that is swiped in a card-reader machine to obtain access to a specific place, instead of entering a code as is the case with ordinary eHCI systems.

HCI and Ubiquitous Computing

A ubiquitous computing environment consists of a group of devices interacting collaboratively with each other. Their interaction is hidden in such a way that it makes the user and the task the central focus. This interaction involves different kinds of information derived from different sources (e.g. users, environments, sensors, etc.). This exchanged information should be collected, shared, analysed, and interpreted, to achieve the goal of seamless and unobtrusive connectivity within the ubiquitous or pervasive environment. In this environment, the eHCI is very complex and might not be a practical or efficient method of interaction that fulfills the requirement of achieving the goal of ubiquitous computing. Furthermore, in this environment, tasks are part of activities, which require many services offered by many devices that can be used simultaneously by many people to perform similar activities. In this heterogeneous and dynamic environment, learners will be overwhelmed by the eHCI

activity as more required services need more computer devices, which require more explicit input from individuals (Poslad, 2009). Note that ubiquitous computing not only deals with implicit inputs, but most implicit interactions are used to enhance and facilitate explicit interactions (Schmidt, 2000). Thus, implicit inputs need to be collected using sensing technologies to reach the goal of the original ideas of ubiquitous computing.

DISCUSSION

In order to provide adequate contextual background to a comparison of m-learning and u-learning, some further clarification is necessary. As previously stated, a ubiquitous environment comprises a number of distinct computer devices carrying out a variety of different tasks, and is thus heterogeneous in nature. Although learning in this environment does not necessitate the carrying of mobile devices by students, a survey by Laine and Joy (2009) showed that the majority of context-aware pervasive environments in the study used such devices extensively for many purposes, including presentations. An assumption of this paper is that both m-learning and u-learning make use of mobile devices, and as such both can be said to represent different applications of similar technologies for the enhanced delivery of learning materials. It could be said therefore, that, m-learning and u-learning are two different ways of applying various technologies to enhance the delivery of learning materials. Two points of confusion in the literature arise from the definitions of the two environments, one relating to the concept of 'anytime anywhere' learning, and the other to the overlap between certain characteristics of u-learning and m-learning. These points will now be discussed in further detail.

Learning Any Time Anywhere

Much of the literature reviewed for the purposes of this research focuses solely on "anywhere and anytime learning" or the learning that cannot be constrained by physical boundaries when defining both m-learning and u-learning. For instance, O"Malley et al. (2003) describe m-learning as, "any sort of learning that happens when the learner is not at a fixed, pre-determined location or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies". In contrast, u-learning is defined as "a new learning paradigm in which we learn about anything at anytime, anywhere utilizing ubiquitous computing technology and infrastructure". With respect to learner   mobility, it is obvious that both definitions are highly similar. As mentioned both of m-learning and u-learning can make use of mobile devices as the medium to present the knowledge to learners, or as an interface between learners and learning materials. When mobile devices are used, learning potentially could take place in any context as the learners go about their everyday activities. Such learning would not be separated from daily functions, such as conversation, reading, surfing the internet, or watching television. Furthermore, these daily functions themselves can serve as a valuable learning resource. Indeed, "learning needs emerge when a person strives to overcome a problem or breakdown in everyday activity" (Vavoula,2004).The description anytime anywhere could be applied to both, as they support the expansion of knowledge. For instance, in the m-learning paradigm, the use of mobile devices is essential for many purposes, such as, access to the internet, access to wireless networks, and interaction with others. Therefore, if learners have access to the internet via 3G or wireless networks, they are able to learn anytime anywhere.

Some Characteristics of U-learning Overlap With M-learning

A large number of u-learning characteristics may also correlate with those of the m-learning environment. Fundamental characteristics of u-learning derived from the literature include; accessibility, permanency, immediacy, interactivity and situation of instructional activities (Campus & Indies, 2010), however for the purpose of this paper only the interactivity characteristic will be considered. The interactivity may be defined as interaction with teachers, peers and experts through either synchronous or asynchronous communication channels, and from a mobility standpoint could potentially be achieved in either u-learning or m-learning environments. Nonetheless, consideration of the characteristic in terms of HCI may help elucidate some differences that are not immediately obvious. Within the m-learning paradigm, learner interaction with teachers, peers and experts is usually achieved through explicit interaction with a mobile device. However, within the u-learning paradigm more intelligent interaction is possible. In this environment, the context of the learner can be identified by the system, allowing automatic referral to appropriate experts or teachers depending on the learner's specific location and problems. Acquisition by the system of implicit inputs in this environment, including learner location, aids in the spontaneous provision of adaptive materials relevant to the learner's location, learning style, proficiency and other circumstances.

HCI as a Differentiator between M-learning and U-learning

In order to further elucidate the distinctions between m-learning and u-learning, consideration must be given to the nature of interaction between learners and mobile devices. Although there are two different interactive modes between humans and computers, referred to as eHCI and iHCI, the former is seen as more strongly identified with m-learning, since explicit provision of personal details (e.g. user name, password, etc.) is required for interaction. An example of eHCI in the m-learning environment is a proposed system for the learning of new vocabulary, in which users send an empty mobile phone email requesting a certain test subject, and are then provided with tests tailored to their profiles (Mengmeng et al. 2010). In many m-learning applications, it can be observed that the learner has to interact explicitly with the application to achieve the intended learning objectives (see Figure 1).

Typically, iHCI is the common interaction in u-learning applications. The application is able to automatically identify the learner and their current context, and then interact with them intelligently and help them to focus on performing specific tasks. For example, Ogata & Yano (2004) proposed a u-learning system that is built to enhance English vocabularies. The system first specifies the location of the user by sensing his/her location to collect needed contextual information (implicit input). Based on these implicit inputs, the system automatically presents a suitable group of vocabularies that suit their current location (implicit output). After that, learners can interact explicitly with the given group of vocabularies to learn. This interaction is eHCI, which will be continually enhanced by the iHCI (see Figure 1).
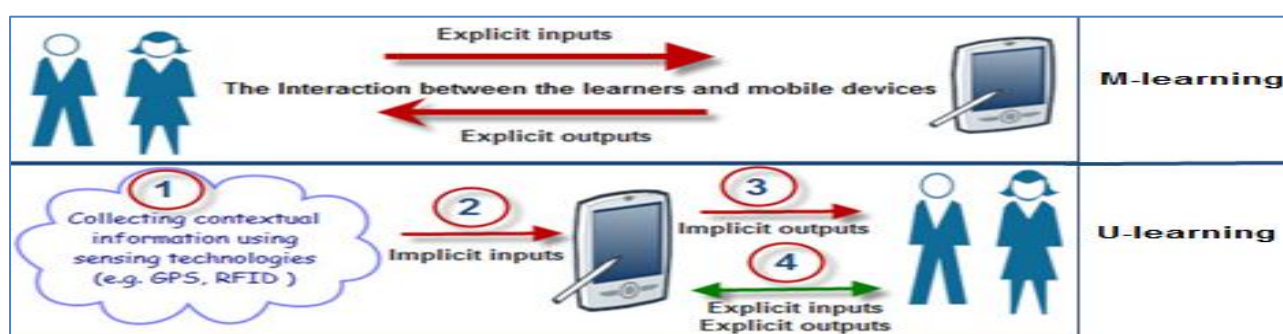
Figure 3:The interactions between learners and mobile devices in mobile and ubiquitous learning environments

CONCLUSIONS

In this paper, mobile learning (m-learning) and ubiquitous learning (u-learning) are compared from the perspective of Human-Computer Interaction (HCI). This comparison was undertaken as both these approaches of enhancing learning make use of the same devices. Using mobile devices in both environments as a presentation tool may lead to misunderstandings when new researchers attempt to differentiate between these learning approaches. The difference between them can be understood by focusing on the required nature of interaction between learners and computer. Two methods of interaction were outlined, explicit HCI (eHCI) and implicit HCI (iHCI). In addition, understanding these methods of interaction is essential in preparation for future devices that can act and react automatically without any human intervention, according to the situational context in which they are used. Both m-learning and u-learning can support the mobility of learners which helps them learn anytime anywhere. Despite their similarity, differences do exist in the nature of interaction between learners and mobile devices. The u-learning environment can, for example, be differentiated by the assimilation of status, circumstance and location data that allows automatic provision of relevant material to learners. More research should be done to investigate the affordability of these devices in order to find the optimal method of interaction with computers that would encourage more efficient learning.

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TOPIC 2: models for learning in a mobile context

Long Papers

The 5R Adaptation Framework for Location-Based Mobile Learning Systems

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ABSTRACT

Utilizing the location-awareness of mobile devices in developing innovative mobile application system has attracted much attention of academic researchers and commercial application developers. Location-based mobile learning systems have taken the advantage of the mobile devices to enhance learner's interaction with the learning context. This paper presents the 5R adaptation framework for location-based mobile learning system, which takes learner, location, time, and mobile device into learning contents generation process and implements a wide-ranging adaptation in the mobile learning environment. As a result, a standard structure for adaptive mobile learning system is proposed.

Author Keywords

Adaptation framework, Location-based mobile learning system, Adaptive learning, location-awareness

INTRODUCTION

Over the past few years we have witnessed significant progress in mobile learning technologies and relevant enabling technologies in computing and information systems. Yet, there are still many challenging issues regarding realizing personalized adaptive mobile learning systems from various perspectives, such as information retrieval, personalized knowledge management, context-aware mobile services management, and so on (Sharples and Roschelle, 2010; Clough, 2010; Garaj, 2010). In this paper, we introduce a conceptual framework for the implementation of adaptive mobile learning systems and discuss an ontology model of the framework in which the factors of learner, location, time, and mobile device are considered in generating personalized learning contents.

The challenge of facilitating mobile learning and ensuring learners' performance depends on appropriately identifying characters of particular learner, the context of learning process and instruction, learning environment and mobile device; and presenting or generating personalized learning contents and instructions dynamically. The time based requirement makes the challenge even harder. On the other hand, predefining adaptive learning contents that might play one-size-fit-all may be costly or impossible in the dynamic mobile learning environment. In general, context-aware systems are expected to acquire and utilize information on the context of a mobile device in order to provide services that are appropriate to particular person, place, time, event, etc. These systems aim to provide context-aware access to information, communication and computation (Hong, 2009, Dey, 2001, etc.).

The semantic technology and ontology based methods are emerging as promising approaches to leverage the presentation and retrieval of dynamic context (Roy, 2010). They can play similar roles in location-based mobile learning to facilitate adaptive learning and personalized learning activities in dynamically changing environment. The challenge facing the development of location-based adaptive learning applications is the ability to deal with these contexts from learning perspective. In doing so, one of the key strategies is to identify and normalize context information based on efficient context-aware data fusion (Roy, 2010) and semantic-based context constraints using composable ontology models. The ontology-based approach uses predefined metadata models of the learning contents, learner models, context information of the learning activities, and mobile device, etc., to retrieve structural and unstructured learning materials and generate personalized, just-in-time, and location-aware learning contents or adaptive "filter" that directs mobile learner to access right contents. In general, as Mitchell, T., etc. pointed out (Mitchell, T., etc. 2009), the future impact of the semantic web will depend critically on the breadth and depth of its content. One can imagine several approaches to constructing this content, including manual content entry by motivated teams of people, convincing owners of existing databases to publish them on

the semantic web, and automatically extracting structured information from the vast quantity of unstructured online text (Tom M. Mitchell, Justin Betteridge, Andrew Carlson, Estevam Hruschka and Richard Wang, 2009). In the mobile elearning application domain, we believe that the ontology-based adaptive learning contents could be generated in the similar patterns of these approaches but we want to explain a little more about the features of these approaches since detailed methods depend on specific application domain and particular requirement of adaptive mobile learning. The first approach is to create semantic learning contents manually. A second approach is to take advantage of pre-existing learning objects and to develop shareable ontologies, publishing learning objects standard, and reward mobile service system to make the learning objects widely accessible. The third approach is to develop software and knowledge retrieval mechanism that automatically identifies appropriate learning components and extracts structural knowledge from unstructured learning contents, e.g. students' discussion forum, and structured learning contents distributed on the web. The third approach depends on so-called near-term approach and uses macro-reading strategy to deal with dynamically changing contents on which emergent socially networked mobile learning or collaborative learning may heavily depend. In our research, we use the second approach to conduct bottom-up development of the ontology for the personalized learning objectives, learning context information and proposed 5R constraint information. We also use the third approach to build and manipulate adaptive "filter" to direct just-in-time retrieval paths during the mobile learning processes. Proposed 5R constraints can be semantically presented and accessed during the automatic decision making process for generating personalized learning content "filter".

The location awareness of the mobile devices provides a distinguishing ability for mobile learning systems to interact with the learning context in mobile learning environment. Enabling the context-aware feature makes mobile devices stand out as a learning media and motivates the development and innovation (Tan et al., 2009). In this paper, the mobile learning is considered non-formal learning but is an organized and structured method of learning external to the formal learning environment. Therefore, learning contents are pre-developed and stored in the learning contents repository of the learning management system. On the other hand, mobile learning is described as learning anytime and anywhere. How to generate learning contents to accommodate when and where the learning is happening is a challenge to the learning management system. The proposed 5R adaptation framework for mobile learning system provides a solution and a standard structure for implementing a wide ranging adaptation in mobile learning environment.

In the following section, the 5R adaptation framework will be explained, followed by the discussion on the significance of the framework. This will be followed by the description of how the 5R adaptation framework works. A scenario study will then be presented to show how to apply the framework. Finally, the paper will be concluded with the discussion on some future directions.

THE 5R ADAPTATION FRAMEWORK

The 5R adaptation concept for location-based mobile learning is stated as: **at the right time, in the right location, through the right device, providing the right contents to the right learner**. This concept, proposed in 2009, aims to enrich adaptive mobile learning by taking the factors of learner, location, time, and mobile device into the adaptation process. The 5R adaptation framework, shown in figure 1, has been gradually developed to continuously enhance its mechanism by applying the 5R concept to the research on location-based mobile learning (Chang and Tan, 2010). The 5R adaptation framework imposes the adaptation constraints of the learner, the location, the time, and the mobile device on the learning contents through the 5R adaptation mechanism to generate the 5R adaptive learning contents. The intention of introducing the 5R adaptation framework is to create a standard structure for mobile learning application systems to implement a wider range of adaptation in mobile learning environment.
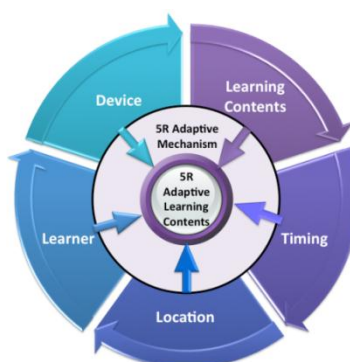
Figure 1 The 5R Adaptation Framework

The Right Time: The time in the adaptation framework indicates two factors, the date-time and the learning progress. The learning contents are developed and stored in the learning management system. Some of the learning contents are with date-time constraint, which means accessing the learning contents depends on when they are available, such as the contents in a lab, library or museum would be available only when these venues are open. On the other hand, learner's learning progress is considered as a time sensitive factor because it can be used as a reference for providing up-to-date learning contents to the learner. Since mobile learning can be conducted anytime, by including the time constraint into the adaptation framework, the mobile learning system is able to provide the learning contents at the right time to the learner accommodating when the learning takes place as well as where the learner is in terms of learning progress.

The Right Location: the location in the adaptation framework indicates the learner's current geographic location. The location-awareness of the mobile device can be employed to sense the current geographic location of the mobile learner who possesses the mobile device being used to conduct mobile learning. Therefore, in a mobile learning environment, the location-based learning contents can be implemented to enhance the contextual interaction for learners. Location-based learning contents are those learning objects that are tied with particular locations. When a mobile learner is physically at or near a particular location, the learner could be assigned to conduct location-based learning activities, such as to visit, observe, and experience the learning objects and to complete learning tasks (fieldwork) at the location. Because mobile learning can be conducted anywhere, by including the location constraint into the adaptation framework, the mobile learning system can provide the right location-based learning contents to the learner according to where the learning takes place. The ability to provide the location adaptation in learning is the unique feature of mobile learning. The key features provided by 5R adaptation framework distinguish location-based mobile learning from traditional adaptive learning.

The Right Device: the device in the adaptation framework refers to the learner's mobile device that is used to conduct mobile learning. The device adaptation is also the distinctive feature of mobile learning compared with other computer- assisted learning scenarios. In the location-based mobile learning environment, client mobile software application needs to run on the mobile device to access the mobile device's native hardware and features. The mobile devices are heterogeneous with multiple operating platforms and they have different and limited user/device interaction capabilities (Tan and Kinshuk, 2009). Therefore, it is essential to provide the right format of learning contents to the right mobile device in order to properly render the contents and to enhance the capability for the learner to interact with the learning contents. The device constraint in the adaptation framework will provide learners the best possible learning experience through mobile device.

The Right Contents: the contents in the adaptation framework include learning objects, learning activities, and leaning instruction. The learning contents can be raw learning materials or pre-developed structured learning materials stored in the learning contents repository of the learning management system. The learning contents can be constructed or retrieved based on the learning objectives and outcomes, pedagogy and structure. The right learning contents will suite the learner's learning objectives and learning style, the particular time and location as well as the mobile device that is being used by the learner to conduct mobile learning. On the other hand, because the learning contents are the knowledge resource of the mobile learning environment, the learning contents generation is crucial. How to collect and develop learning contents into the learning contents repository is very important aspect in developing the mobile learning environment. The learning contents in the learning contents repository have to be properly described and tagged so that the contents could be easily constructed and retrieved by the adaptation mechanism. The physical location-based learning objects, which are either indoor or outdoor, have to be properly tagged in order for the mobile devices to sense or identify them automatically or manually.

The Right Learner: the learner in the adaptation framework is the person who conducts learning through mobile device in the mobile learning environment. A learner plays the main role in mobile learning. In this 5R adaptation framework, a learner's learning profile and learning style have been taken into account in order for the learning system to identify the learner's individuality and personality among the learners in the mobile learning environment. The learner's information contains the static and dynamic data mainly including the learner's learning objectives, learning progress, learning behaviors, and learning assessment results. The data is either manually entered into or automatically collected from the learning management system before or while the learner conducts his/her learning in the mobile learning environment. The right learner means that the learning objects provided, the learning activities assigned, and the pedagogy used by the learning management system to the learner match the learner's learning profile and learning style .The learner's learning patterns and behaviors could also be used to build the learner's learning model to dynamically update the learner's personal information, to effectively analyze and predict the learner's learning performance and outcomes, and to provide the learner with optimized and personalized learning assistance.

The 5R Adaptation Mechanism: the adaptation mechanism consists of the adaptive mathematic model, algorithms, and controls to process the inputs and to generate the 5R adapted learning contents for the learner in the mobile learning environment. The adaptive mathematic model is represented in equation 1,

$$C_R(i) = \mathcal{R} \ (C(i), (L(i), T(i), P(i), D(i))) \tag{1}$$

where $C_R(i)$ is the output of the 5R adaptation mechanism representing the right learning contents, $C(i)$ is the input representing learning contents, $L(i)$ is the input representing the location constrains, $T(i)$ is the input representing the time constrains, $P(i)$ is the input representing the learner constrains, $D(i)$ is the input representing the mobile device constrains, and $\mathcal{R}$ is the mathematic representation. The $\mathcal{R}$ could be varied according to the complexity of the 5R adaptation mechanism. It could be just set representation, so the output is simply an intersection set of the input learning contents set with the union set of other 4 input sets as shown in equation 2,

$$C_R(i) = C(i) \cap (L(i) \ \cup \ T(i) \cup P(i) \ \cup D(i)) \tag{2}$$

or it could be more complicated matrix representation as shown in equation 3:

$$
\mathbf{C}_{R^{(i)}} =
\begin{bmatrix}
C_{R-L^{(i)}} \\
C_{R-T^{(i)}} \\
C_{R-P^{(i)}} \\
C_{R-D^{(i)}}
\end{bmatrix}
=
\begin{bmatrix}
L_1 & T_1 & P_1 & D_1 \\
L_2 & T_2 & P_2 & D_2 \\
\vdots & \vdots & \vdots & \vdots \\
L_n & T_n & P_n & D_n
\end{bmatrix}
\begin{bmatrix}
C_{L^{(i)}} \\
C_{T^{(i)}} \\
C_{P^{(i)}} \\
C_{D^{(i)}}
\end{bmatrix}
\tag{3}
$$

in which $\mathbf{C_R(i)}$ matrix is one of the right learning contents, the 4 x n matrix represents the controls generated from each constraint input model or algorithm, the $\mathbf{C(i)}$ 4 x 1 matrix represents one of the input learning contents, and $C_L, C_T, \ C_P$ and $C_D,$ respectively represent location, time, learner, and device properties of the learning contents. The processing model of the 5R adaptation mechanism is shown in figure 2. The processing model could be different from the one shown in figure 2, and obviously their processing performances would therefore be different.
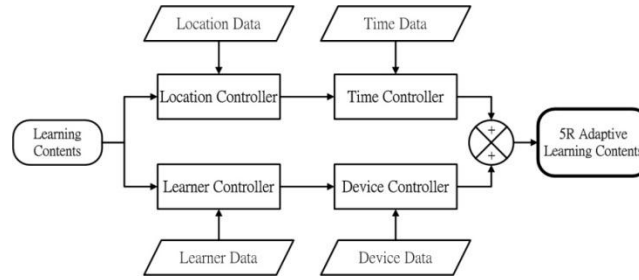
Figure 2 The 5R adaptation mechanism process model

THE SIGNIFICANCE OF THE 5R ADAPTATION FRAMEWORK

Traditionally adaptive learning indicates personalized teaching and learning. The learner as a stakeholder in learning is the essential focus of any education system and education technology. Adaptive education has been a very important educational method for more than two-thousand years, since at least the Confucius time. However, classroom-learning environments are typically not conducive to such adaptive education. With the development of computer technology and the Internet, eLearning or online learning has become more and more popular, allowing learning to be conducted on the individual basis. The learning contents and pedagogy can be designed to accommodate the individual learner's needs and convenience. eLearning provides a platform to implement adaptive learning approach, which can facilitate learning communication and collaboration to transform the learner from passive receptor of information to collaborator in the educational process (Paramythis and Reisinger, 2004).

Mobile learning is considered as an extended form of eLearning with its own characteristics. In the location-based mobile learning environment, the 5R adaptation framework naturally focuses on the mobile learner. The motivation of the framework is to provide mobile learners with adaptive learning contents based on their learning profiles and learning styles, additionally to adapt mobile learners' current locations, times and devices. Furthermore, a location-based learning object could be associated with different learning contents to serve different learning objectives. For example, for a historic building used as legislative assembly of a province, a learner in the history discipline could be provided with the location-based learning contents related to the building's history while a learner in political science could be offered politics related information. In the

5R adaptation framework, the same learning contents could be constructed differently according to the learners' learning styles, which could significantly impact the learners' learning performances.

It is not very common to include physical sites and objects, such as historic places, geographically and geologically interesting spots, interesting architectures, landmark buildings, and museums in course materials as the learning objects if they are far from instructor's location, even if they may be right next to where the learner is. In the location-based mobile learning environment, the learner is supposed to be mobile and the learning can be conducted anytime and anywhere, and therefore, it is possible to implement the location-based learning and to assign location-based learning activities to the learners in related sites and with objects where the learners are. In the mobile learning environment, the location-based learning contents have their location and time properties, i.e. they are tagged by location and time. One learning content can be associated with many location-based learning objects that could be physically distributed in different geographical locations. The mobile learning system is required to be able to track down where the learner is and to know which location-based learning objects are near the learner and if they are accessible at this time. Thus, the system has the capability to automatically alert the learner when the learner is approaching or is at a particular location, and then guide the learner to study with those learning objects. With the 5R adaptation framework, by knowing the learner's current location and time acquired from the learner's mobile device as well as the pre-registered information of the learner and his/her mobile device, the system can use the data as the constraint input for the 5R adaptation mechanism to retrieve or construct the learning contents from the location-based learning contents repository and to provide the right learning contents to the learner at the right time in the right location. Within the 5R adaptation framework, the learning system provides the adaptive learning contents that not only have personalized adaptation but also have location, time, and device adaptation.

In the mobile learning environment, proper delivery of the learning contents through the mobile device has huge impact on the learner. Because of the heterogeneity and limited user interface size and functionality of mobile devices, a learner could be very frustrated by not being able to display the learning contents, such as not being able to see flash components on an iPhone, restricted layout, difficulty in the interaction with the device, and so on. Therefore, device adaptation becomes an important issue in mobile learning. The adapted learning contents lead learners to concentrate on the learning contents and to conduct their learning effectively and pleasantly. Contents presented out of context could cause huge distraction and demotivation. In the 5R adaptation framework, knowing learners' mobile device information, the system is capable to choose learning contents in the right format for the learners' mobile devices in order to greatly improve the learners' learning experiences in the mobile learning environment.

THE IMPLEMENTATION OF THE 5R ADAPTATION FRAMEWORK

To implement the 5R adaptation framework in the location-based mobile learning environment, two critical aspects need to be considered, namely location-based learning contents creation and 5R adaptation mechanism design. In order to implement the framework, it is essential to solve the issues of how to describe or tag the location-based learning contents and how to build the relationship among the four adaptation constraints and learning contents.

The 5R Components Ontology: the term "ontology" in the 5R adaptation framework is used to describe the five adaptation inputs, to identify the data structures, to explicitly and formally specify their relationships, unlike the way ontology usually uses "terms" to denote the important concepts as classes of objects and "relationships" to include hierarchies of the classes (Antonious, and van Harmelen, 2008). The ontology of the 5R inputs is shown in figure 3.
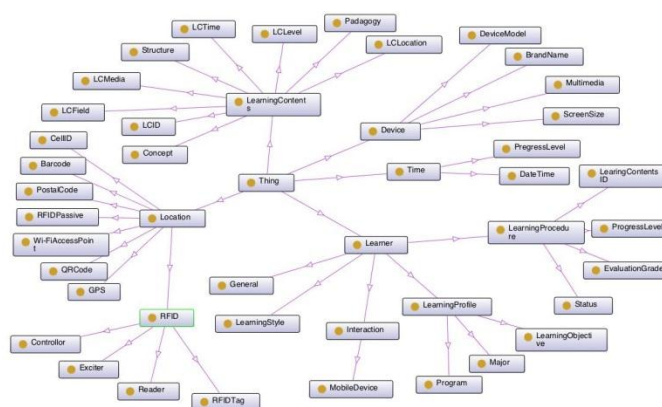
Figure 3 The 5R components ontology   Figure 4 The 5R inputs ontology schema
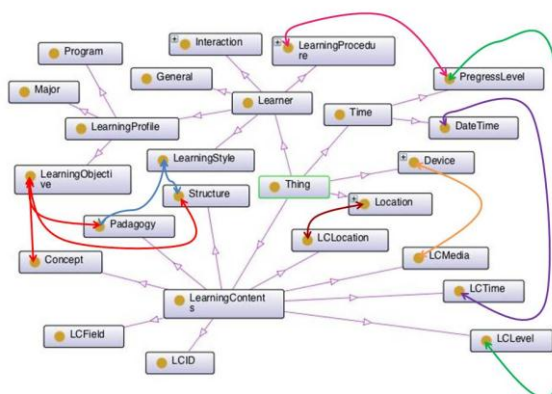
In figure 3, the "Thing" represents the 5R adaptation inputs. The first layer consists of "Location", "Time", "Learner", "Device", and "LearningContents", respectively representing the five adaptation inputs. The second layer is the further description of information or data of each adaptation input. Further extension of the hierarchies of each adaptation input in the ontology depends on whether there is enough information to describe and relate the input with other inputs in the 5R adaptation framework in order to execute the adaptation mechanism. The ontology scheme, namely, the relationships among the adaptation inputs is shown in figure 4, which illustrates why the inputs need to be described as shown in figure 3 and how the inputs are interconnected.

The Adaptive Mobile Learning System Architecture: the system architecture is designed based on the 5R adaptation framework. The adaptation mechanism and process shown in figure 5 reflect the conceptual ontology schema illustrated in figure 4. In the mobile learning application system, a location-based learning contents creation platform is used for the instructors to develop location-based learning contents. The platform is designed based on the 5R input ontology that ensures all the learning contents developed to be used by the 5R adaptation mechanism. Moreover, the 5R adaptation mechanism could be viewed as a meta-architecture for the application system architecture in which different design or implementation strategies could be applied as long as the architecture and functions of mobile learning application comply with the 5R adaptation constraints and key relation models. Different applications of the 5R-constrained implementation may have different system performance, usability, maintainability, cost, and so on, but the system-level balance and optimization should be conducted to reach specific goals.
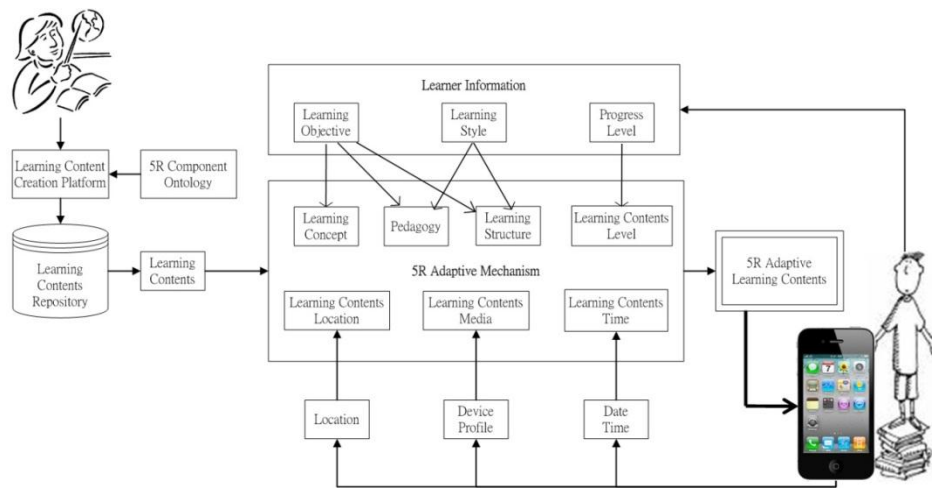
Figure 5. The 5R adaptation mobile learning system architecture

THE 5R ADAPTATION FRAMEWORK APPLICATION SCENAIRO

In this section, location-based mobile fieldtrip applications using visualized interaction with dynamic geospatial data are presented as a scenario for applying the 5R adaptation framework.

Understanding the concepts and mechanism of glacial processes in geomorphology study is part of learning tasks in geography course. With the help of the fieldtrip, students can better understand why glacial landscapes look the way they do, understand landform history and dynamics, and predict future changes through a combination of onsite field observations, physical experiments or analyses, and numerical modeling based on the onsite data collection, measurement and analysis model.

As illustrated in figure 6, students in the ice fieldtrip are arranged into different groups in which they conduct the field observations in specific zones around ice field, such as main glacier, medial moraine, truncated spurs, or cirques, and so on. When students enter a specific zone, the system automatically retrieves relevant learning contents and provides location-based visualized interaction with students who observe the features of the landform, measure and collect data, and enter the data and annotation into the system via visualized fieldtrip interaction language provided in the mobile application.

The 5R adaptation features represented in this scenario:

1. *Location-based experiment Lab interface and visualized interaction on mobile devices*

Fieldtrip Lab experiment system is a location-aware application on mobile devices that provides students with visual language or manipulation functions to allow them to conduct all learning and experiment activities through mobile devices in the field. The conceptual architecture of the system is illustrated in figure 7.

2. *Adaptive learning content retrieval constrained by the location and ongoing fieldtrip activities*

System responds to the individual student requests based on student's learning objectives in the fieldtrip and student models, and provides individual students with adaptive content links to the course material to fit specific requirement in the fieldtrip study and experiment activities at the location with the right format matching to the student's mobile device.

3. *Visualized fieldtrip plan, real-time activity collaboration and monitoring during the fieldtrip, as illustrated in figure 6*

Visualized fieldtrip planner allows students to plan collaborative learning activities in the fieldtrip in terms of the location selection, schedule, and students' decision making for joining or disjoining pre-existing study groups or regrouping upon various learning objectives or changing fieldtrip activities in the dynamic environment. The fieldtrip process monitor allows students to observe their own activities and current locations through visualized monitor application.

4. *Dynamic annotation or blog on the visualized semantic physical object model, as partially illustrated in figure 6*

One of important tasks for the student in the fieldtrip is to collect data and do instant analysis and collaborative study using the data and course materials in the context of the trip activities. Visualized semantic physical object model represents spatial relations between the physical onsite objects and students' activities surround those objects   in the semantic information so that the fieldtrip management system could real-timely track students' context in the fieldtrip and leverage the advanced functions of automatically retrieving information generated during the fieldtrip, such as current location, ongoing tasks at the location, and annotation or data collection at the location. All the interactions between the student and the mobile device and the collected data onsite are stamped by the time and the location.

5. *Real-time sharing experience between students and others who are in the field or in remote areas via visualized virtual interaction interface*

Onsite collaboration and sharing various learning activities and data collection experience between geographically distributed learners during the fieldtrip experiment process are the key features in the system. Visualized virtual interaction interface allows for retrieving available XML-based geographic annotation, adding individuals' annotation, and uploading XML-based geographic annotation into remote geographical information programs, such as Google Earth etc., and for browsing visualized fieldtrip information and real-time data from individual mobile browsers.

Figure 6 Fieldtrip in the different zones of the ice field

CONCLUSIONS

This paper introduces a principle framework to leverage the application system design and implementation towards proposed 5R constrained adaptive mobile learning systems. The 5R adaptation framework could be used as a meta architecture to guide or constrain the development of a specific mobile learning system by means of particular requirement of the learning objectives, learning activities, learners' characters, the features of mobile

services and environment in which the adaptive mobile learning activities conduct.   The paper demonstrates how the 5R adaptation framework has been applied in our ongoing project using mobile applications for the geography fieldtrip study. The scenario illustrated in the paper extends the view on what 5R adaptation means in the mobile learning applications and how flexible it is to be realized. With the rapid development of mobile technologies, new features of mobile devices will become available to enhance the adaptation constrains and the 5R adaptation framework is also expected to evolute more and more sophisticate. In order to effective implement the 5R adaptation framework, future study should also address the 5R adaptation mechanism in order to find the optimal solutions for adaptive mobile learning.
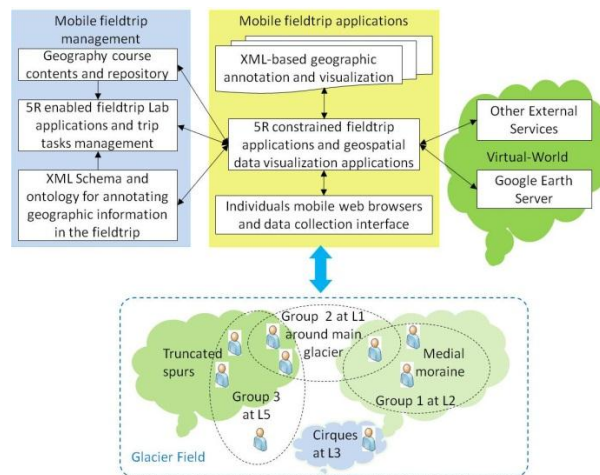
Figure 7 The conceptual architecture of the Location-based mobile fieldtrip application system

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A Dynamic Construction Model of Learning Content Suitable for Learners' Mobile Environments

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ABSTRACT

In recent years, a great deal of mobile learning content has been developed and is being used in schools. Much of this content depends on the mobile environment (e.g., the type and specification of the mobile devices, the learning place), the grade and skill level of students which are determined in advance. In addition, many content components are combined into packages. These conditions make it difficult to change a specific part of the learning content as the mobile environment changes. Consequently, in the current situation each content package has to be updated as a whole, and the cost of this is significant. To make updating content easier and less expensive, in this research we have developed a dynamic learning-content construction model. In this model, a learning content is regarded as a set of the minimum components. This model makes it possible to partially change the units of learning content, and we expect it to promote dynamic learning-content construction and the reuse of learning content.

Author Keywords

learning content, dynamic construction, mobile environment, suitable method

INTRODUCTION

As increasingly functional mobile devices – such as iPhone, iPad and Android devices – continue to be developed and their use continues to spread, the opportunity to use mobile devices in learning is growing (Barnes and Herring, 2011). Compared with earlier cellular phones, the most significant characteristic of the latest smart phones and similar devices is that the input/output interface has evolved and become easier to use.

Much of the existing content for mobile learning consists of sets of packaged content, and it has been developed by assuming a specific student model based on, for example, the target grade, learning level, and learning time (Takahashi, 2004). This limits the usefulness of such content since it cannot be adapted according to a learner's level and mobile environment, and content addition, deletion, and modification is not easy.

This paper aims to develop a dynamic learning-content construction model in order to solve these problems. In this model, learning content is regarded as a set of minimum components, and the conventional concept of managing learning content on the basis of a whole package is avoided – each minimum component of the learning content is managed independently. This model makes it possible to partially change the components of

learning content, and we expect it to enable the dynamic construction of learning content suitable for each learner's level and mobile environment and to promote the reuse of learning content.

In this paper, we first examine the ideal method to construct learning content, starting with an investigation of the composition of existing learning content.

CURRENT STATE OF LEARNING CONTENT AND A PLAN FOR THE FUTURE

Analysis of the Current State

We analysed the current state with respect to learning content based on the experience of authors and the results from research regarding learning content from several sources.

Much of the present learning content was developed as packages targeted in advance at a particular school grade, student level, or similar criteria. Partial substitution and modification of the content is difficult, and entire packages have to be replaced when changes become necessary. This leads to problems such as the high cost to replace content, the difficulty of reusing content, and out-of-date content. These problems can be categorized as follows:

Problem (1) Content is not suitable for a person's learning level

Problem (2) Insufficient consideration of a learner's mobile environment (learning place, valid times, mobile device type and specifications, etc.)

Problem (3) Fixed packages of learning content prevent any addition, deletion, or modification of content

Problem (4) The amount of available learning content does not grow

To solve these four problems, we have developed a dynamic mobile learning-content construction model.

Basic Approach

The problems associated with current learning content originate in how learning content is constructed. Each set of learning content is assembled as a complete package and it is difficult to examine and replace any component of the content making up a package. Therefore, in our research, we have avoided the "package" concept and solved the problems listed above by developing a model where learning content is constructed as a set of minimum components. Through this model, the existing fixed learning content becomes learning content suitable for each learner's level, mobile environment, and other needs. Since the addition and deletion of minimum components of any content is enabled, we expect to see a greater variety of learning content to result.

In this research, we realize that each component of learning content is constructed from a set with the meaning of each learning-content component used as the minimum component of the learning content. In this paper, we call each minimum component a "learning content minimum object (LMO)."

Model Construction Requirements

In our model development based on LMOs, we extracted the following requirements as being necessary to enable practical use of the model.

Requirement (1) Requirements for the overall model: the learning-content construction model currently being assumed.

All the learning content is regarded as a set of LMOs. Therefore, changes and additions to an LMO are easily made by managing all the LMOs independently, without managing the learning content on a per package basis. Generally, since a learning content is a set of LMOs with certain relations among the LMOs –for example, a target grade or a learning-content level– a "learning-content construction network (LCCN)" has to be developed to express the relations among LMOs as a model. Moreover meta-information for the LCCN is also required.

Requirement (2) Requirements for learning-content construction: the learning-contents construction currently being assumed.

The following scenario of learning-content construction is assumed and examined. A learner/teacher searches an LMO of interest. For example, a report or a question regarding an incident on the information moral domain, which has recently become the center of attention, is chosen. We would like to dynamically construct learning content suitable for a target learner based on this selected LMO. In that case, restrictions regarding the learner's mobile environment (the type and specifications of the mobile device, the learning place), the learner's grade, the level, the total learning time, etc. are entered into a development system. The system constructs variations of the learning content corresponding to the input information, and shows these to the student or teacher. This capability is aimed at solving Problems (1) and (2).

We have to build the LCCN from LMOs so that such an activity can be performed.

Requirement (3) Requirements for learning content renewal: construction of the relations between a newly added LMO and other LMOs.

In general, the variety of learning content is not easy to increase. To alleviate this problem, LMOs which are freshly developed or modified by a teacher are registered into an LCCN as learning-content components. After that, they are open for sharing. Therefore, a system can create a relation structure between the added LMO and other LMOs (Fig. 1). In this case, the system requests the teacher or student to input information about the LMO. This alone is insufficient and other LMOs closely related to the added LMO may exist, so the added LMO must autonomously create relations as much as possible by searching for other closely related LMOs. In this way, relations with LMOs that otherwise tend to be buried are created, and the possibility of reuse improves.

Since modification and addition are done through LMOs in our model, compared with the conventional technique of replacing all as a package, our model enables much easier modification and addition. This solves Problems (3) and (4).

Stronger guarantees as to the quality of learning content are needed. Furthermore, significant relations based on actual practice need to be applied to strengthen relations between corresponding LMOs. Therefore, a mechanism allowing feedback by the student or teacher is needed.

Requirement (4) Requirements for compliance with e-learning content standards

New e-learning content needs to be realized from a set of extracted LMOs. To allow this, a mechanism is needed to enable the construction of content from LMOs according to an international standard. For example, our model must be able to generate learning content based on international standards, such as SCORM (ADLnet).
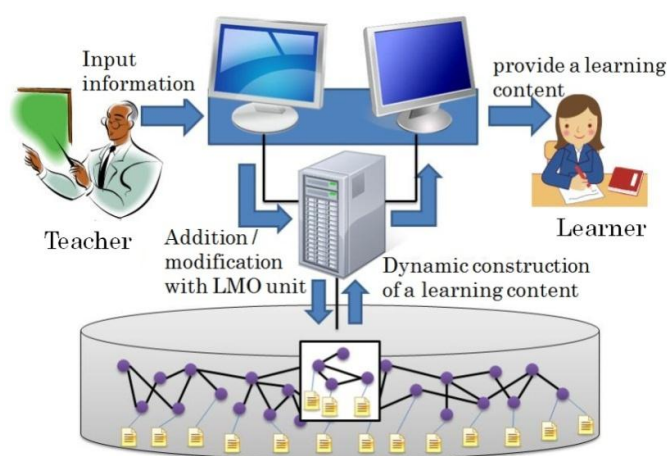
Figure 1.   Image of a dynamic learning-content construction method

INVESTIGATION OF MODELING

Modeling procedure

To examine the applicability of the model described in Section 2.3, we investigated 26 examples of existing learning content (e.g., NICER; NCTD; CEC; CIRE). The model development was carried out according to the following procedures:

(1) Divide learning content into LMOs
(2) Group the LMOs
(3) Extract the information by which a LMO is characterized, additional information, and the information by which the relation between LMOs is characterized
(4) Decide on a model framework
(5) Formulate the model.
The results of the modelling analysis are shown below.

Divide learning content into LMOs

We tried to divide learning content into the minimum components (LMOs). As a result, we found that each LMO should just assume one screen on a personal digital device, exercise of a unit, explanation screen, and others.

Group the LMOs

We classified LMOs according to the learning content; that is, into four groups of "elementary explanation", "problem answer", "confirmation explanation", and "knowledge addition." Moreover, the loose order of these groups was looked.

We found that there are various content file types, and when learning using a mobile device is assumed it is necessary to take these file types into consideration.

Extraction of characteristic information

Through the construction of learning content by appropriately selecting LMOs classified as described in Section 3.3, dynamic content construction that adapts to learners and their mobile environment can be achieved. Therefore, information which can characterize an LMO and information which can characterize a relation between LMOs is extracted (Tables 1 and 2). This information is meta-information of the LMOs.

Table 1 Information which can characterize an LMO

item	explanation
title	LMO title information
explanation	LMO explanatory information
keywords	A set of key words that characterize the LMO
enforcement_time	Assumed learning time
creation_time	Date and time LMO was created
update_time	Date and time LMO was updated
author	LMO author
file_type	LMO file type
resource	Entity of the file
mobile_env	Mobile environment (type of mobile device, learning place)

Table 2 Information which can characterize a relation between LMOs

item	explanation
group	Group to which LMO belongs
school_type	School type to which LMO belongs (elementary school, junior high school, high school, university, general)
content_level	Assumed study level (beginner, middle, advanced)
grade	Assumed grade
learning_style	Learning method (lecture, training (individual), training (group), discussion, self-study)
importance	Learning content importance
pre_cond	Relation to an LMO whose learning content should be learned in advance according to a precondition
follow_cond	Relation to the contents of learning which should be performed following the learning back concerned of LMO

Model Outline

Figure 2 shows an outline of the learning-content construction model based on the discussion in Sections 3.2 – 3.4. Learning content can be constituted dynamically by choosing suitable LMOs using the LMO meta-information. The ideal learning content construction is achieved by choosing LMOs from every groups.
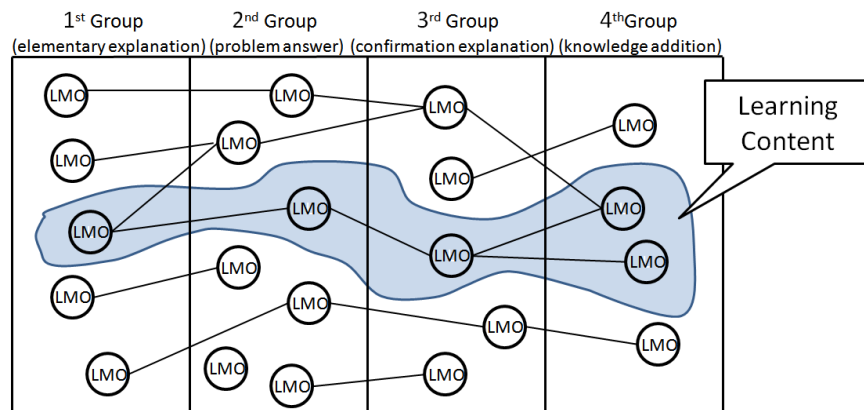
Figure 2 Learning-Content Construction Model

MODEL FORMULIZATION

In this research, learning content is regarded as a set of minimum components (LMOs). Since each LMO has some relation with other LMOs, a set of LMOs is constructed through the extraction of LMOs by going across the relations based on certain conditions. This set becomes a learning content. To apply this concept, the following the LCCN is defined using graph theory.

[Definition 1] A <u>learning-content construction network (LCCN)</u> G consists of 2 elements: G=(V, E). V is a finite set of LMOs. v (V∍v) is a node of the network and expresses an LMO. E is a finite set of relations. e (Ed∍e) is a relation of the network and expresses a relation between LMOs. Here, e=(v_i, v_j), and E ∍ v_i, v_j. //

An LMO has two sets of attributes.

[Definition 2] A <u>profile attribute</u> is meta-information of an LMO and expresses characteristics of the LMO. A profile attribute is defined as nine elements, and is expressed as $AttProf_V$ = { title, explanation, keywords, enforcement_time, creation_time, update_time, author, file_type, resource }. Each attribute has a meaning as follows: "title" is the title information put onto the LMO; "explanation" is explanatory information; "keywords" is a set of key words that characterize the LMO; "enforcement_time" is the assumed learning time; "creation_time" is the date and time of creation; "update_time" is the date and time of updating; "author" is the manufacturer; "file_type" is the LMO file type; and "resource" is the enitiy of the file. When O is assumed to be an LMO, each attribute value is written as title(O). //

[Definition 3] A <u>construction attribute</u> is a set of meta-information used when the relation between LMOs is constructed. The composition attribute is defined as six elements, and is expressed as $AttConst_V$ = { group, school_type, content_level, grade, learning_style, mobile_env }. Each attribute has the following meaning: "group" means the group that an LMO belongs to, and has either an "elementary explanation", "problem answer", "confirmation explanation", or "knowledge addition" value; "school_type" is the kind of school (elementary, junior high, etc.); "content_level" is the study level (a value of 1-3); "grade" is the school year; "learning_style" is the class and study method; and "mobile_env" is the mobile environment which includes characteristics such as the mobile device, the learning place, and so on. //

[Definition 4] A <u>relation attribute</u> is a set of meta-information that accompanies the LCCN relation. A relation attribute is defined as sets of seven elements, and is expressed as $AttRelation_E$ = { (kind, direction, experValue, needsValue, importance, pre_cond, follow_cond) }. Each attribute has the following meaning: "kind" means the kind of relation, and has either a "School kind", "Learning content level", "School year", "Class and learning method" or "keywords" value; "direction" means the direction of the relation, and has either a "previous group", "next group", "high", "low" or "resemblance" value; "experValue" is a user experience value and has a value of 1-3; "needsValue" represents necessity and has a value of 1-3; "importance" is an importance value for an LMO in the learning content and has a value of 1-3; "pre_cond" is the strength of the premise knowledge to be assumed and has a value of 1-3; and "follow_cond" is the strength of the subsequent knowledge to be assumed, and it has a value of 1-3. //

By constructing such an LCCN on a computer system, dynamic construction of learning content suitable for a mobile environment and the class design can be obtained. The constraint of the relations between LMOs obtained from the analysis result of Section 3 is formulated as follows.

[Definition 5] Constraints for learning content construction

Let O be a focused LMO, and O_i (i=1,…) be selection candidates of LMOs. The constraints for the learning content construction are formulated as follows.

C1: Same school kind.
　　Extract O_i , such that school_type(O) = school_type(O_i) is satisfied.
C2(n): A learning-content level is made as equal as possible.
　　Extract O_i, such that |content_level(O) – content_level(O_i)| ≤ n is satisfied. If n=0, the extraction is performed on the same level. If n=1, the extraction is performed on the level including the next level.
C3(n): The grade is the same as much as possible.
　　Extract O_i, such that |grade(O) – grade(O_i)| ≤ n is satisfied. If n=0, the extraction is performed on the same grade. If n≥1, the extraction is performed across n grades.
C4: Same learning method.
　　Extract O_i, such that learning_style (O_i) = learning _style (O) is satisfied.
C5: The same keywords.
　　Extract O_i, such that Keywords(O)^Keywords(Oi) ≠ϕ is satisfied.
C6(Keys): It has the specified keywords.
　　Extract O_i, such that keyword(O_i) = { key } is satisfied.

C7(n): Not related to the far group.

Extract O_i, such that $|group(O) - group(O_i)| \leq n$ is satisfied. If n=0, the extraction is performed on the same group. If n≥1, the extraction is performed across n groups.

C8: The same author.

Extract O_i, such that author(O) = author(O_i) is satisfied.

C9: LMO with a high use experience value.

Extract O_i which has a relation with the highest experValue.

C10: LMO with a high needs value.

Extract O_i which has a relation with the highest needsValue.

C11: The newest LMO.

Extract O_i, such that $Newest_{(j=1...M)}($ creation_time(O_i) $)$ is the minimum. Here, Newest is a function which takes the newest LMO.

C12: Learning time

Let T be the assumed learning time, and O_1 -- O_k be extracted LMOs. $\Sigma_{(i=1,k)}$enforcement_time(O_i) < T is satisfied.

C13: LMO with high importance.

Extract O_i, such that importance(O_i) is the highest.

C14: LMO with high precondition.

Extract O_i, such that precondition(O_i) is the highest.

C15: LMO with high follow condition.

Extract O_i, such that followcondition(O_i) is the highest.

These 15 constraints are utilized as a part of construction attribute in the case of an addition of LMOs to the LCCN and in the case of their modification. In this case, the combination of constraints serves as parameters of an LMO addition. Moreover, the combination of constraints is used for the extraction of LMOs.

These constraints are installed as an independent module and LMO addition and extraction are realized by calling the modules with consideration of a specific order according to the situation.

DYNAMIC CONSTRUCTION METHOD

Based on the LCCN defined in Section 4, we now discuss the methods for (1) the dynamic construction of learning content suitable for a learner's mobile environments, a lesson design, and the learner's level, (2) LMO modification and addition of a new LMO into an LCCN.

Dynamic construction method of learning content suitable for the learner's situation

Learning-content construction currently assumes that a teacher presents some conditions and one LMO of interest is chosen from the LMO groups. LMOs of a higher rank and a low rank group related to the selected LMO are selected one by one, and finally, a construction operation will be completed if (Σenforcement_time(extracted LMOs)) is settled within the assumed learning time. If this is not settled, the group is appropriately thinned out and its LMOs are re-selected within the assumed learning time. These works are realized by combining the constraints shown by definition 5. We then prepare the following function:

$$get\_LMO\_from(i)with(C_j, \ldots, C_k)$$

This is a function which extracts an LMO that satisfies the restrictions $C_j, ...,C_k$, from the *i-th* group. According to an extraction scene, the constraints used as a parameter are appropriately substituted.

Below, the dynamic construction algorithm of an accommodative learner's mobile environment is proposed.

```
Input K;        #school type
      L;        #level
        G;        #grade
        M;        #learning methods
        Key;    #set of keywords
        T;        #learning time to assume
Lmo = extracted LMO based on the constraints;
G = group(Lmo);
LMO(g) = Lmo;
*1: While( i: such that i is a group that is not group(Lmo){
        A level and the width of a grade are appropriately changed if necessary.;
        LMO(i) = get_LMO_from(i)with(C1, …, C15);
}
total =Σ(i=1,4)enforcement_time(Lmo(i));
if( total < T ) {
        The width of a group is changed.;
```

```
        goto *1;
    }
            for( all the selectedLMO(i) )
                experValue(LOM(i)) = experValue(LMO(i))+1;
    end.
```

The constructed learning content is regarded as a packaged set of LMOs, and will be in an actually usable state. The reliability of learning content improves by using it frequently. Therefore "experValue" which is the usage experience value of the LMOs of the learning content increases, and the relation between LMOs becomes strong. Furthermore, the learning content will be improved by sharing the "experValue" as feedback from the teacher after using the learning content.

Modification of an LMO and dynamic addition of a new LMO to an LCCN

An LMO added or modified by a teacher has to develop relations with other LMOs contained in an LCCN. Thus, an added LMO needs to have a profile attribute, a construction attribute and constraints for content construction in advance. Consequently, for example, relation construction beyond a school year grade is also attained, and/or relation construction between different school types is also attained. Like these, an added LMO is expected to autonomously carry out the relation construction planned by a teacher. When teachers want a strong relation between the additional LMO and the target LMOs, they can set a high value to the "needsValue".

PROTOTYPE SYSTEM

We developed a prototype system for generating the learning contents based on the proposed model. This system consists of three subsystems: a study management subsystem, a learning-content composition control subsystem, and the LMO management subsystem. The development language used MySQL as the database for PHP and HTML.

Here, an example of the operation interface at the time of a teacher generating learning content (learning-content set file) which uses this prototype will be shown.

(1) LMO extraction

A teacher inputs the information on the learning content to be created (Figure 4).

Figure 4. LMO Extraction

(2) LMO Recommendation

The system recommends and displays LMOs that can become candidates from the 1st group to the 4th group, based on the proposed content construction method by using the information of (1). Figure 5 shows an example of the recommendation. The teacher decides to use one LMO, and then the system dynamically evaluates attribute information regarding the LMO and provides LMOs related to the one selected by the teacher.

(3) Completion of learning contents construction

When learning content is constructed by repeating the task of (2) and the teacher pushes the "Completion" button, the construction is complete. The system then displays the learning content construction map on the screen.
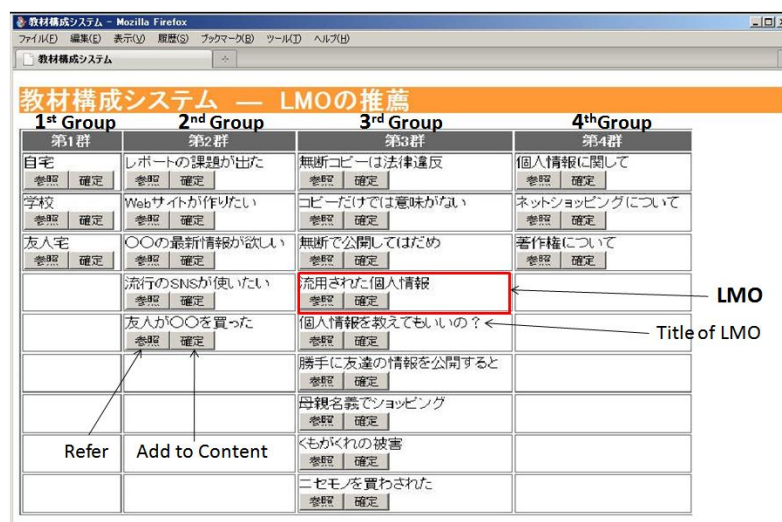
Figure 5. Recommendation Screen

(4) Generation of learning content (generation of learning content set file)

After completing the task of (3), the system generates the learning content set files (convert to SCORM) according to the learning content construction grammar. The generated learning content set file is managed by the learning content database. Figure 6 shows an example of the screen of the generated learning content.

Figure 6. Example of learning content screen

CONCLUSION

In this paper, we have examined a model for the dynamic construction of learning content that is suitable for a learner's mobile environment and the teacher's class design, and so on. We have also developed formal models of LMO and LCCN. In addition the development of a prototype system to generate learning content based on the models was also examined.

Future work will involve trials where we will generate actual learning content to evaluate the model and to further improve the dynamic configuration technique.

ACKNOWLEDGMENTS

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Computational models for Mobile Learning Objects

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ABSTRACT

Mobile learning is considered the newest step of eLearning, supported by mobile computing (Caudill, 2007). Learning objects are proposed in order to enhance reusability of digital educative contents in different learning contexts (Polsani, 2003). Mobile Learning Objects (MLOs) are learning objects aimed at being used in mobile learning environments (Castillo, 2007). In this paper we present our proposal of computational models for the design, development and use of MLOs. These models support the learning approaches and corresponding awareness which sustain mobile learning (Sharples, 2005)(Wang, 2001). We present three models: personalization model, aimed at supporting personalized learning, and knowledge awareness, collaboration model, aimed at supporting collaborative learning, with social and knowledge awareness, and interaction model, aimed at supporting situated learning, and context awareness. These computational models were implemented as belief systems based on DLV (Datalog Disjunctive), a programming system of the Answer Set Programming paradigm (Leone, 2002). We also present results of testing these models in a simulated mobile learning environment.

Author Keywords

Mobile Learning, Learning Objects, Computational models, Answer Set Programming.

INTRODUCTION

Nowadays there is interest to properly exploit the reusability that learning objects (LOs) promise in mobile learning contexts. The coupling of mobile learning characteristics with those of the learning objects prefigures a powerful concept to support anywhere-anytime learning using mobile devices. Table 1 shows a comparison of some of the few works on this matter. In this table it can be seen the evolution towards the concept of Mobile Learning Objects, and towards the adaptation of LO standards to mobile learning.

Proposal	Concept of LO for mLearning	Learning approaches and awareness
Katz &Worsham, 2005.	No LO concept specific for mLearning.	No learning approaches, nor needed awareness. Attempt to apply SCORM 2004 standard "as is" to mLearning.
MILO, Holzinger et al., 2005.	Need to adapt LOs to the computational characteristics of mobile technologies.	Situated learning. None awareness. None LO standard.
MobyL, Patokorpi et al., 2007.	Need to enhance the LO concept to mLearning.	Constructivism, situated collaboration, and personalized learning, this last as future work. No needed awareness. None LO standard.
MLO, Castillo and Ayala (2007)	Need to enhance the LO concept, and also to adapt LO standards to mLearning.	Situated, collaborative and personalized learning. Context, social and knowledge awareness. Adaptation of SCORM 2004 standard.

Table 1. Comparison of proposals for LOs for mLearning

MOBILE LEARNING OBJECTS

A mobile learning object is an interactive software component, personalized and reusable in different contexts, designed to support an educational objective through a mobile device in situated or collaborative learning activities (Castillo, 2007). In the paper Towards a Theory of Mobile Learning, Sharples et al. (2005) offer an initial framework for theorizing about mobile learning. Based on this proposal, we consider situated learning,

collaborative learning and personalized learning as the learning approaches supporting MLOs. Milrad (2003), referring to Klopfer et al., discusses on the features of mobile devices in education. Taking into account these features, MLOs characteristics are reusability, portability, and social interactivity. In Table 2 it is shown how we relate these characteristics to learning approaches.

Mobile Learning Object Characteristic	Learning Approach
Portability, merging digital and physical realms.	Situated Learning.
Social interactivity and connectivity.	Collaborative Learning.
Reusability, individuality and context sensitivity.	Personalized Learning.

Table 2. MLOs characteristics and learning approaches

In order to properly use Learning Objects in Mobile Learning Environments, computational models are needed to assure effective design, development and use of these digital learning contents entities.

DLV, A PROGRAMMING SYSTEM BASED ON THE ANSWER SET PROGRAMMING PARADIGM

The Answer Set Programming (ASP) paradigm is more expressive than normal (disjunction free) logic programming, and allows us to deal with uncertainty. It uses two types of negation: weak negation (not X), that means "I don't know anything about of X", and strong negation (~X) which means "I know that X is false". DLV (Data Log disjunctive) is an implementation of the ASP paradigm.

In DLV's programs it is permitted the use of disjunctions in the heads of the rules and negation may occur in the bodies of the rules. A program in DLV is a finite set of rules and facts possibly including integrity constraints. These features made this programming paradigm a powerful tool for knowledge representation, non monotonic reasoning and modeling of incomplete knowledge. DLV follows Prolog's syntax convention. Strings starting with lowercase letters are facts or constants, while strings starting with uppercase letters are variables. Underscore ("_") denotes the anonymous or wildcard variable, which purpose is to specify that an argument can be ignored or does not matter in the rule where it appears (Leone, 2002).

The advantages of DLV as a theoretical framework to model learners are (Ayala, 2005): i) The formal specification as a set of rules and facts, allows us to infer beliefs about the learner as answer sets, which are correct, consistent and coherent models, ii) The use of weak and strong negations allows us to infer derived beliefs with incomplete and uncertain information, iii) The possibility of using integrity restrictions allows us to add conditions that eliminate inconsistent elements from the model, and, iv) It is possible to formalize the model in terms of logic predicates.

LEARNING APPROACHES AND AWARENESS SUPPORTED BY COMPUTATIONAL MODELS

On the one hand, based on the proposal of Wang and Chee (2001), we consider that in a mobile learning environment, the learner must be aware of the MLOs available in her context, particularly those that may be of her interest, as well as aware of other learners accessible in her location (context awareness); the interests and capabilities of the other learners who are collaborating with her in a common task via similar or common mobile learning objects (social awareness) (Prasolova, 2002); and the experiences of use of the knowledge represented in a given mobile learning object, applied in specific situations (knowledge awareness) (Ogata, 2004). On the other hand, based in Sharples (2005) proposal, MLOs must support personalized, collaborative and situated learning. In Table 3 we show the three proposed computational models, with respective awareness and learning approaches.

Computational model	Learning approach	Type of awareness
Interaction model	Situated learning	Context awareness
Collaboration model	Collaborative learning	Social and knowledge awareness
Personalization model	Personalized learning	Knowledge awareness

Table 3. Computational models, learning approaches and corresponding awareness types.

CHARACTERISTICS OF MLOS AND LEARNING TASKS

In our proposal, each MLO is defined as a set of five elements (Castillo, 2010b):

- *learningObjectId*: A unique identifier for each MLOs.

- *KnowledgeElementId*: Id of knowledge element contained in the MLO.

- *TopicId*: Id of the topic the MLO is about of.

- *KnowledgeRepresentedInObject*: The knowledge represented in object.

- *ContendId*: Id of the content included in the MLO.

Therefore, an MLO is defined in DVL as follows:

```
mobileLearningObject(learningObjectId,knowledgeElementId,topicId,
            knowledgeRepresentedInObject,contendId).
```

There is also a set of learning task the learner must to do to learn. Each learning task is defined as a set of three elements:

- *taskId*: A unique task Id.

- *LearningObjectId*: Id of the MLO involved in this learning task.

- *KnowledgeRepresentedInObject*:   The knowledge represented in the MLO involved in this task.

Therefore, learning tasks are defined by the statement:

```
learningTask(taskId,learningObjectId,knowledgeRepresentedInObject).
```

COMPUTATIONAL MODELS

Personalization model

The personalization model is aimed at supporting reusability and individuality in the user interaction, as well as knowledge awareness. To implement a personalized learning approach, the personalization model must support personal recommendations of specific MLOs to particular learners. The personalization model also implies a software component that keeps the learner model updated by monitoring her interaction with the mobile learning object. Our learner model is the set of beliefs (Self, 1994), and the set of inferring rules, that the system has about the interests and capabilities of a specific learner (Ayala, 2003). A belief representation is used, instead of a knowledge representation, because a computational model of beliefs is an appropriate way to represent user models in learning environments (Ayala, 2008). A beliefs system manager allows the addition of basic beliefs about the capabilities of the learner, when the learner explicitly indicates that she has accomplished a learning task, or when it infers that she is interested in a topic, based on the MLOs the learner has interacted with. Using these basic beliefs, and a set of rules, the beliefs system manager is able to infer the capabilities and interests of specific learners, generating the set of beliefs which, together with inferring rules, comprises our learner model.

In personalization model, the interests of learner are inferred by the following DLV rule:

```
hasInterestInTopic(LearnerId,TopicId) :-
      learnerAvailable(LearnerId),
      mobileLearningObject(LearningObjectId,_,TopicId,_,_),
      haveInteractedWithALearningObject(LearnerId,LearningObjectId).
```

To consider a learner capable of interact with an MLO, she must have accomplished a learning task which implied the interaction with that MLO and its knowledge content, as showed in the following rule:

$\forall$ LearningObjId,TaskId,LearnerId : **knowledgeUsedInTask**(LearningObjId,TaskId) $\land$
    hasAccomplishedTask(LearnerId,TaskId)
      $\rightarrow$ **capability**(LearnerId,LearningObjId)

On the other hand, to consider a learner not capable of interact with an MLO, she must have not accomplished a learning task which implied the interaction with that MLO and its knowledge content, as showed in the following rule:

$\forall$ LearningObjId,TaskId,LearnerId : **knowledgeUsedInTask**(LearningObjId,TaskId) $\land$
    ~hasAccomplishedTask(LearnerId,TaskId)
      $\rightarrow$ ~capability(LearnerId,LearningObjId)

The recommendation of a specific learning object to a particular learner, according to her interests and/or capabilities, is generated by the rule:

∀ LearnerId,KnowledgeElementId,LearningObjectId :
      learnerAvailable(LearnerId) ∧
      hasInterestInTopic(LearnerId,TopicId) ∧
      topicOfKnowledge(TopicId,KnowledgeElementId) ∧
      knowledgeRepresentedInObject(KnowledgeElementId,LearningObjectId) ∧
         not capability(LearnerId,LearningObjectId)
         →
         learningObjectRecommendation(LearnerId,KnowledgeElementId, LearningObjectId)

Collaboration model

The collaboration model allows social interactivity and connectivity, supporting the communication of those who have been interacting with a given mobile learning object (knowledge awareness), and awareness of the interests and capabilities of other learners (social awareness). The collaboration model provides assistance recommendations, applying the following rule expressed in DLV:

```
assistanceRecommendation(KnowledgeElementId,LearnerId) :-
        capability(LearnerId,KnowledgeElementId),
        learnerAvailable(LearnerId).
```

By means of this rule, the collaboration model recommends a learner as a potential assistant for interact with a knowledge element if that learner is currently available, and she is already capable of interact with that knowledge element.

Interaction Model

The interaction model is a computational model for the adaptation of educational contents to particular devices. It also keeps the learner aware of other learners and mobile learning objects (knowledge awareness) supporting portability and the merging of digital and physical realms. The tasks of the interaction model are described as follows:

1. Make the learner aware of mobile learning objects according to her interests, reducing information overload. The applied rules to accomplish this are:

```
haveToMakeAwareOfLearningObject(LearnerId,KnowledgeElementId,LearningObjectId) :-
        learnerAvailable(LearnerId),
      hasInterestInTopic(LearnerId,TopicId),
      topicOfKnowledge(TopicId,KnowledgeElementId),
        mobileLearningObject(LearningObjectId,_,TopicId,_,_),
      knowledgeRepresentedInObject(KnowledgeElementId,LearningObjectId),
          not haveInteractedWithALearningObject(LearnerId,LearningObjectId).
```

This rule makes aware a learner about available MLOs containing knowledge elements concerning topic of her interests if she has not interacted with these MLOs. Next rule makes aware a learner about available MLOs containing knowledge elements concerning topic of her interests if she is not capable of use these MLOs.

2. Make the learner aware of other available learners, who are related to a given MLO based on information about their capabilities. The rule to accomplish is:

```
haveToMakeAwareOfOtherLearner(LearnerId,LearningObjectId,OtherLearnerId) :-
        learnerAvailable(LearnerId),
        learnerAvailable(OtherLearnerId),
        OtherLearnerId <> LearnerId,
      isInteractingWithALearningObject(LearnerId, LearningObjectId),
         haveInteractedWithALearningObject(OtherLearner,LearningObjectId),
        capability(OtherLearnerId, LearningObjectId).
```

This rule recommends a potential collaborator if there is another learner currently available which has interacted with the MLO the learner is interacting with at present time.

3. Interaction model is also responsible to achieve adaptation of contents to user's specific mobile devices. In order to accomplish this, we prototyped CARIME (Content Adapter of Resources In Mobile learning Environments) (Castillo, 2010a). CARIME access a database containing profile information about

diverse mobile devices in order to obtain features of specific user's mobile device. CARIME also needs information about some features of the contents of MLOs. The Mobile Device Requirements category of ALMA's metadata set includes two tags which refer to the minimum acceptable screen size for the presentation of the contents, and the format of the content, in case of graphics, audio and/or video. With both of these sets of data, CARIME will be able to determine the feasibility of the adaptation and, in such a case, to adapt the contents of the MLO to be properly presented to the current learner in her device.

Testing scenarios and results

In order to test our computational models, we simulated a second language learning scenario, with three categories of MLOs: Vocabulary MLOs, Expression MLOs, and Grammar Rule MLOs. We simulated four scenarios based on the following combinations of capabilities and interests of learners (Figure 1):

i)   Learners with similar capabilities and similar interests.

ii) Learners with different capabilities and similar interests

iii) Learners with similar capabilities and different interests

iv) Learners with different capabilities and different interests.

Figure 1 shows the four quadrants that these combinations produce. For each one of these quadrants, we simulated learning activities for a set of four learners.
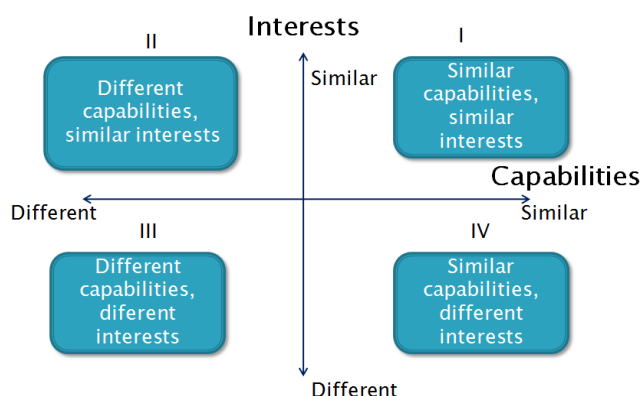
Figure 4. Combinations of learners capabilities and interests

Figure 2 summarizes results from test for learners with similar capabilities and similar interests. It shows that in this scenario there are two topics of interest. Computational models did recommend two MLOs about topic 1, one MLO about topic 2, and had to make aware about three available MLOs related to learners' interests.

Figure 3 summarizes results from test for learners with different capabilities and similar interests. It shows that in this scenario there are three topics of interest. Computational models did recommend two MLOs about topic 1, two MLOs about topic 2, two MLO about topic 3, and had to make aware about six available MLOs related to learners' interests.

Figure 4 summarizes results from test for learners with different capabilities and different interests. It shows that in this scenario there are four topics of interest. Computational models did recommend two MLOs about topic 1, two MLOs about topic 2, two MLOs about topic 3, two MLOs about topic 4, and had to make aware about eight available MLOs related to learners' interests.

Figure 5 summarizes results from test for learners with similar capabilities, and different interests. It shows that in this scenario there are five topics of interest. Computational models did recommend two MLOs about topic 1, one MLO about topic 2, two MLOs about topic 3, two MLOs about topic 4, and two MLOs about topic 5, and had to make aware about nine available MLOs related to learners' interests.

Every tests show that, in mobile learning environments with different combinations of capabilities and interests of learners, and MLOs about different topics, developed models accomplished their task. In all test scenarios, the personalization model inferred learner interests and recommend related MLOs. In all test scenarios, collaboration model did recommend potential assistants to interact with MLOs based on inferred capabilities of learners. In every test scenarios, interaction model makes aware learners of available MLOs of their interests, and it makes aware a learner of current available co-learner while interacting with a MLO previously dominated by that

co-learner. It can be seen that as there are more different interests and capabilities in the environment, there are more recommended MLOs, as expected, because recommendations is based on interests and capabilities.
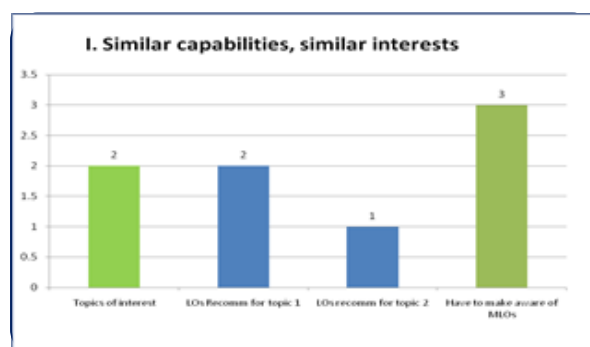
Figure 2. Results for learners with similar capabilities and interests.
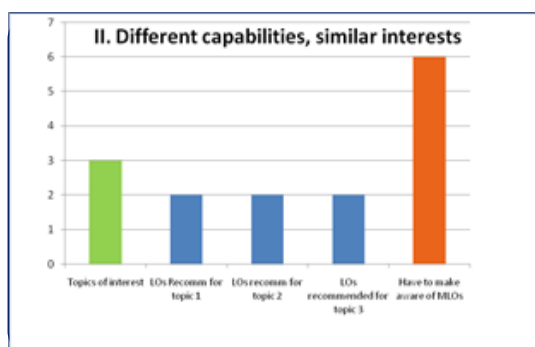
Figure 3. Results for learners with different capabilities and similar interests.
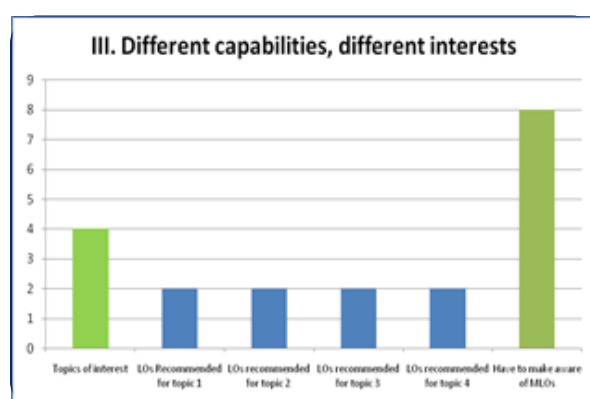
Figure 4. Results for learners with different capabilities and interests.
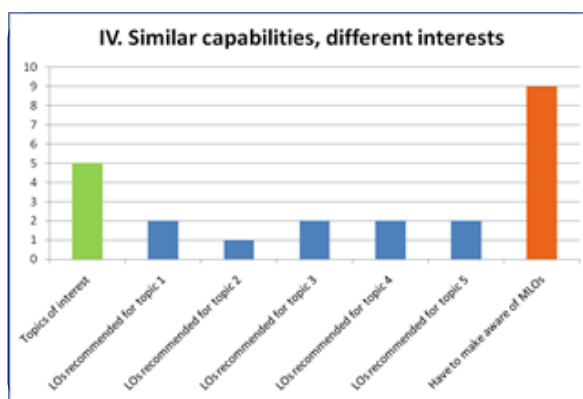
Figure 5. Results for learners with similar capabilities and different interests.

CONCLUSIONS

In this paper we presented three computational models for the design, development and use of Mobile Learning Objects. These models are implemented in DLV, and consist of a set of rules and inferred beliefs. Personalization model is aimed at supporting personalized learning and context awareness; interaction model is aimed at supporting situated learning and knowledge awareness; collaboration model is aimed at supporting collaborative learning and social and knowledge awareness. Models were tested in a simulated mobile learning environment with MLOs about different topics, and diverse sets of learners, combining different capabilities and interests. Result showed that computational models carry out their task, inferring interests and capabilities of learners, recommending available MLOs based on learning interests, and making learners aware of potential assistants.

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TOPIC 3: mobile learning: theory, design and pedagogy

Long Papers

Designing Mobile Communication Tools: A Framework to Enhance Motivation in Online Learning Environment

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ABSTRACT

Resulting from the widespread deployment of wireless technologies and the high rates of mobile device use and ownership, online learning is evolving from desktop computers to mobile devices. Mobile communication technology is considered to be effective in promoting learner motivation and encouraging interaction between learners and instructors as well as among peers in online learning environments. This paper explores the design and development of an extension to a Learning Management System (LMS) onto mobile devices guided by a mobile communication tools framework to enhance learner motivation. This underpinning framework was based on a combination of Keller's ARCS (attention, relevance, confidence, satisfaction) motivation model and a collaboration factor. Related studies, the system design, and accompanying architectural issues are discussed in this paper, along with the results of a pilot investigation into learners' responses to its use. The results provide a better understanding of the role of mobile technology in higher education, encourage the further development of mobile communication tools, and shed light on mobile learners' motivation as compared to traditional modes of online learning.

Author Keywords

mobile communication tool, motivation, Leaning Management System, Moodle, m-Learning, e-Learning, online learning

INTRODUCTION

A learner's motivation has an impact on the quality and effectiveness of any form of learning. Learners are more motivated when they have frequent contact with instructors and peers, and physical separation in online learning environments can cause loneliness, resulting in a lack of a sense of community (Bai, 2003). Existing communication tools in e-Learning systems, such as weblogs, forum discussions, and chat, can be used to support learner motivation and perceived learning; however the high dropout rate suggests that these tools cannot support the high degree of learner motivation and perceived learning required (Chaiprasurt & Esichaikul, 2010).

The benefits of m-Learning include the convenience that comes with small and lightweight devices, the availability of space and time for learning, the adaptability of content according to individual needs, and the facilitation of sustained connections between learners and instructors. Moreover, m-Learning has the potential to increase flexibility by customizing the learning approach to deliver a more personalized and learner-centered activity. Drawing from the literature on informal learning and m-Learning, Jones et al. (2006) identified six factors of m-Learning motivation: control (over a learner's goal), ownership, continuity between contexts, learning-in-context, communication, and fun. With respect to appropriate learner interaction in the development of usable m-Learning, each of these features boosts motivation, leading us to identify which aspects of mobile device use might enhance online learners' motivation and engagement in the e-learning process.

THEORETICAL BACKGROUND AND RELATED STUDIES

The use of motivation in online learning environments plays an important role in the ongoing process of learning and interaction, not only in instructional design, but also in the use of communication tools and electronic resources (ChanLin, 2009). The model of motivation used in this study involves ARCS and the collaboration factor. The ARCS model is explored further within its realms of attention, relevance, confidence, and satisfaction.

The ARCS Model

Previous approaches to motivational design in online learning environments have mostly been based on Keller's ARCS model, researched and confirmed for validity in various learning and design environments, such as the traditional classroom; computer-assisted instruction; blended learning environments; and in online, distance and Web-based learning settings (e.g., ChanLin, 2009; Chyung, 2001; Huang et al., 2006; Visser, 2002). Termed a problem-solving approach to designing the motivational aspects of learning environments (Keller, 1987), the ARCS model is based on a synthesis of motivational concepts and theories of human motivation that focus on learners' motivation to learn, and the manipulation of instruction and learning settings to influence learner motivation (Mao & Thompson, 2007). It identifies four essential strategic components for enhancing motivation in instruction, with sub-categories for each component to facilitate the design process.

Attention

Attention is prerequisite to motivating the learning process. Strategies to gain and sustain the learner's attention and interest in the instructional content include (Keller, 1987):

- *Perception arousal* – including challenging, unexpected, or frequent communication, as well as rapid feedback following a task.

- *Inquiry arousal* – referring to stimulating information-seeking behavior. Keller (1987) postulated that this can be accomplished by asking questions or having the learner solve problems.

- *Variation* – to keep learners' interest from waning. Comprising a range of presentations, methods, media, and unexpected events, variation accommodates learners' unique needs and preferences.

Relevance

Relevance is defined as a person's perception of attraction toward desired outcomes, ideas, or other people, based upon their own goals, motives, and values—in other words, the relation of the instructional content to things that are meaningful to the learners. The relevance of the course material can be emphasized by relating the instruction or the content to the learners' personal goals, needs, interests, and motives through (Keller, 1987):

- *Goal orientation* – When learners can perceive the steps toward their desire end goal, they have developed a goal-oriented motivation helping them to recognise immediate objectives to achieve their future goals and demonstrate the utility of the instruction.

- *Motive matching* – Keller (1987) indicated that providing the learners with appropriate choices, responsibilities, and influences will help improve the effectiveness of an instructional product. Motive matching should provide opportunities for learners to perceive the instructional requirements that are consistent with their goals and compatible with their learning styles.

- *Familiarity* –The use of concrete examples and concepts should create a connection between the instruction and the learners' experience.

Confidence

Confidence is generally described as a person's expectation to do things well or deal with situations successfully. In an educational context, this refers to the learners' belief in their own abilities related to the perceived outcomes of their activities. When learners believe they have the ability to control the outcomes of their behavior, they invest more effort into the pursuit of their achievement and are more motivated to be successful. The concept of confidence can be broken down into three areas (Keller, 1987):

- *Learning requirements* – When initiating a learning task, it is important to help learners build positive expectations for success by indicating requirements in a clear manner. An additional help option should provide the learners with further understanding of the learning requirements and how to be successful.

- *Success opportunities* – Learners gain confidence in their own ability when the belief in their own confidence is supported or enhanced by the learning experience, which should provide challenging and meaningful opportunities to establish a belief in the ability to achieve successful learning.

- *Personal control* – The learners should clearly know that their success is based on their abilities and efforts. They should be provided with feedback on the quality of their performance and helped to associate their success with their abilities and efforts.

Satisfaction

Satisfaction is termed a positive feeling about what has been achieved in the learning context (Visser et al., 2002). Satisfaction serves to increase learners' motivation, which can be intrinsic or extrinsic, by providing reinforcement for the efforts given by the learners in the activities. The concept of satisfaction can be broken down into three areas (Keller, 2010):

- *Intrinsic reinforcement* – Providing meaningful opportunities for learners to use their newly acquired knowledge will give them satisfaction in learning. Such opportunities should also reinforce learners' pride of achievement and affirm the importance of the learning experience.

- *Extrinsic rewards* – Providing motivational feedback and positive reinforcement are methods of increasing satisfaction. Extrinsic rewards should include feedback about learners' performance and reinforcement of the learners' success.

- *Equity* – Equity encourages motivation and achievement through the use of consistent standards and rewards for success. A clear consistency between assignments and objectives is a helpful motivational strategy to build satisfaction in learners.

Collaborative Learning

Collaboration is defined as working together with another person or group to accomplish shared goals, and the terms cooperative and collaborative learning are often used interchangeably. While collaborative learning relies more on the quality of exchanged information or shared resources to achieve a common goal by a group of participants, cooperative structures are designed to improve performance by encouraging, increasing, and helping one another through interactions during activities (Slavin, 1995; Schunk et al., 2010). Cooperative learning as a strategy for promoting learners' motivation (Slavin, 1995) confirms the suggestions of previous research studies (Sharan & Shaulov, 1990; Johnson & Johnson, 1989) that cooperative learning enhances learners' motivation more than the traditional whole class. For collaboration, peer discussions must be made to develop the participants' sense of community within their particular group, and collaborative learning—widely acknowledged in its ability to make learners more motivated to learn (Miyake, 2007)—emphasizes activities that support learning through social interaction. Collaborative activities have been found to significantly improve the effectiveness of a learning experience, increasing both individual and group performance (Webb & Palincsar, 1996). Whereas online learning is unlike traditional face-to-face learning, where social presence and a sense of community is encouraged, it can enhance persistence and motivation in due course (Rovai, 2002) so long as online learners have sufficient opportunity to interact with each other, and continuous encouragement for their learning efforts.

A MOBILE COMMUNICATION TOOLS FRAMEWORK

Based on the analysis of motivational factors, the characteristics of mobile technologies, and the potential of such technologies to promote and increase human interactions, this study proposed the integration of mobile communication tools into an e-Learning system. Table 1 illustrates how the ARCS model and collaboration factor were utilized as a framework for developing mobile communication tools in existing e-Learning systems. This study developed the proposed framework based on Moodle (a Learning Management System or LMS), or Virtual Learning Environment, used for creating quality online courses and managing learner outcomes. Considering the ability of SMS (Short Message Service) to make learning more widely accessible than other mobile communication tools, SMS messages acted as the main supplementary tool integrated into the LMS to enhance learner motivation.

Motivational factors	Mobile Communication Tools
Attention: arousal and sustainment of learners' curiosity and interest in the instruction or learning activities.	SMS (asking questions, course notifications & announcements)
	Mobile RSS Feeds (the topic of contents, forums, news)
	Mobile Instant Messaging (MIM)
Relevance: relation of the instruction to the learner's needs, interests, and motives.	SMS (URL related instruction & course information)
	Assignment Feedback Tool
	Mobile Instant Messaging (MIM)
	Mobile Polls and Votes
	Mobile Blogging
Confidence: learner's expectation of a successful learning experience.	Performance Gradebook Tool
	Assignment Feedback Tool
	Attendance Reporting Tool
Satisfaction: learner's sense of achievement regarding the learning activities or experiences.	Mobile Blogging
	SMS (reinforcing feedback and grading results)
	Performance Gradebook Tool
Collaboration: working together with another learner or group to accomplish shared goals.	Mobile Blogging
	Mobile Instant Messaging (MIM)
	Mobile Polls and Votes

Table 4. A mobile communication tools framework

Short Message Service (SMS)

This study allowed the instructor to deliver bulk SMS messages from Moodle with the help of the Text Messaging System, which retrieves messages and phone numbers as they are texted from Moodle. Bulk SMS services that were provided to learners, according to motivation factors, were as follows:

- *Attention:* SMS (course notifications and announcements) allowed the instructor to text messages to learners who had not yet completed some of the activities in Moodle, such as submitting their assignment, viewing course material, and posting to a discussion forum. The instructor was able to select the learners to receive the message and write a text notification to them in Moodle. Such SMS course reminders were intended to stimulate and sustain a learner's curiosity and interest. Similarly, through SMS, the instructor could text questions to selected learners that were specifically intended to help learners think and learn about a subject. Frequently asked questions based on what learners have learned in the lesson were expected to stimulate their attitude of inquiry and naturally challenge their thinking.

- *Relevance*: SMS (URL-related instruction and course information) allowed the instructor to select learners who have neither earned a good score nor submitted the assignment. The instructor could then help them to understand through detailed explanations, or by text linked to a URL, where detailed feedback is posted, how the instruction in which they were participating could either contribute to solving their problem or enrich their performance.

- *Satisfaction:* SMS (reinforcing feedback and grading results) constituted words of affirmation, encouragement, praise, or recognition, and therefore differed in this study from general feedback. SMS reinforcement allowed the instructor to tell learners that what they were doing in the LMS was working well. Providing timely, adequate, and encouraging feedback in the form of reinforcement helped to maintain the desired performance.

Figure 1 shows the default page of the system. Once a learner has logged in and selected a desired online course, the learner was directed to the main page of the system, consisting of seven tools, described below.

Mobile RSS Feeds

Mobile RSS Feeds enabled learners to view and manage all RSS forums and news in Moodle on their mobile phone. To do so, an effective RSS reader is required on the learners' mobile device, allowing the learner to select and bookmark the RSS feeds, and synchronize with their mobile devices in a way that is suitable to their individual learning styles and needs.

- *Attention* – Mobile RSS Feeds are designed to retain the learner's interest, accommodate a variety of the learner's unique needs and learning preferences, and support attention factors leading to improvements in the learner's motivation in an e-Learning system.

Figure 5. Mobile Communication Tools Menu   **Figure 6. Mobile Polls and Votes**   **Figure 7. Mobile Blogging Menu**
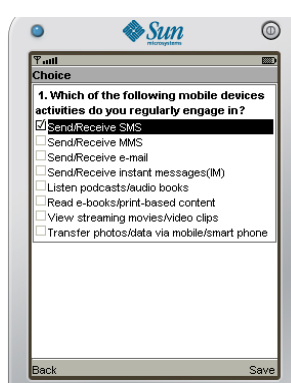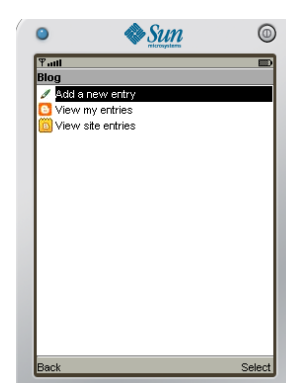
Attendance Reporting Tool

Learners could verify course hours attended in Moodle for each selected duration (today, yesterday, current week, previous week, current month, previous month, and all days). Besides an individual's online duration, learners could also view their percentage and average attendance for the whole session, page hits, and other attendance statistics including percentages, ranks, averages, as well as lows and highs.

- *Confidence* – By attending the e-Learning system regularly, the learner is more likely to keep up with daily course activities. It is important to let learners know that they are solely responsible for their

success through their personal efforts and abilities by indicating their attendance in a definable manner, in turn helping learners to feel that they have control over the outcome of their study.

Performance Gradebook Tool

The Performance Gradebook Tool was a graded report on the quality of an individual learner's performance. This tool provided a graded element (grades for each assessment), rank (the position of each element in relation to the rest of the class), and percentage in a similar manner to the Moodle Grader Report.

- *Confidence* – Clearly informing and measuring performance by grading the learners' work helped them to believe in their potential success, making them more likely to exert the effort required to be successful.

- *Satisfaction* – The Performance Gradebook Tool provided all absolute marks and grades given for each assignment, examination, or other course activity within a Moodle course. Equity issues range from providing consistent assessment standards for all learners' activities to keeping them informed about their progress through the tool, anytime and anywhere.

Assignment Feedback Tool

The mobile feedback tool was intended to provide personal, individualized information to a particular aspect of a learner's work in Moodle for a quicker, more convenient way to access feedback. The tool allowed learners to view individual feedback on each assignment directly, and continue to learn from it at anytime and anywhere, using their mobile device.

- *Relevance* – The instructor could use the feedback tool to give learners background knowledge about what a question was asking and to give them a link to more information.

- *Confidence* – Gathering assignment feedback seems to improve the learners' confidence. From the feedback they received, they could either try to improve or maintain a certain aspect of their competence, which could in turn increase their self-confidence.

Mobile Polls and Votes

The mobile polls allowed participants to select one choice from a variety of options provided by the instructor in Moodle (see Figure 2). The instructor could also define a time window within which participants were allowed to make a choice. This allowed participants to change their minds before the final date, making changes that were automatically displayed by Moodle.

- *Relevance* – Polling via mobile devices was potentially a way to attract and engage learners to view results and additional related activity in the e-Learning system. It was potentially useful in stimulating thinking about a topic, and articulating existing knowledge and understanding.

- *Collaboration* – The instructor created a poll on the Moodle website, and participants to the survey responded using their mobile devices. Mobile polls provided an easy way for learners to express their opinions and determine where they stood against fellow peers.

Mobile Blogging (Moblogging)

Mobile Blogging (also known as Moblogging) is a form of blogging that allows people to share online journals and discuss various topics directly on the Web from mobile devices. In this study, learners created and updated their own blogs in Moodle by simply sending images and/or text from their mobile devices. (see Figure 3).

- *Relevance* – Mobile Blogging related the instruction to learners' experiences and offered real world relevance to daily circumstances for them.

- *Satisfaction* – Mobile Blogging enabled learners to remotely update their comments and pictures in an authentic context anytime and anywhere on the Moodle blog website. It represented an attempt to encourage and support the learners' intrinsic enjoyment of newly acquired knowledge with the opportunity to relate their instruction to personal experiences in real settings.

- *Collaboration* – Mobile Blogging helped to establish a collaborative learning environment for learners in virtual classrooms. Learners could snap photos with the tool and then easily upload the pictures with text descriptions directly to their Moodle blog. Their peers were also able to update comments and view a list of blog entries using Mobile Blogging or Moodle blog. Learners were afforded the opportunity to share their experiences, embed them within an authentic context of use, and bring reality closer to their peers and instructor.

Mobile Instant Messaging (MIM)

MIM is a text form of communication which involves immediate correspondence between two or more people via a mobile device. MIM allowed users in this study who were enrolled in the Moodle course to send and receive messages to and from other users via Moodle Messaging System.

- *Attention* – The instructor was able to send a message to selected course participants in Moodle to notify them of events like forum posts, which learners could then read through MIM. The tool helped to make explicit the need to take into account the varying stimulation needs of learners who differ in their traits and state.

- *Relevance* – MIM supported the instructor in making instruction responsive to learners' motives and values by accommodating different learning needs and styles.

- *Collaboration* – MIM integrated into the Moodle Messaging System gave learners a tool to share information, instantly communicate, and improve teamwork with the capability to collaborate not only synchronously, but also asynchronously, through peer discussions. Learners had the ability to keep in touch with their peers on mobile devices when they were away from Moodle's Helpdesk.

SYSTEM ARCHITECTURE

This study mainly focused on the design and development of tools for enhancing learner motivation rather than content delivery. The basis of the proposed framework was developed by Moodle, an open source e-Learning software platform where the learner is significantly involved. Figure 4 demonstrates the systematic overview of the proposed tools integrated into existing Moodle LMS and Web Services. The architecture is divided into three components: e-Learning client, m-Learning client, and server. These three components are described in detail in the following sections.

E-Learning Client

As the presentation layer of an e-Learning system, the e-Learning client provides learning materials delivered by a web browser. This layer not only delivers HTML code to the user, combining images, static content, and layout, but also supports interaction, application, and content-specific interfaces for each registered user. The document templates, user interface views, and all users' customized applications are developed as objects and retrieved on demand. In Moodle, with which the study was engaged, this layer is implemented using PHP. This study attempted to maintain the original presentation layer of Moodle; however, some user interfaces, along with their implementations, were added to support the proposed tools.

M-Learning Client

The m-Learning client consists mainly of two components: the mobile communication tools and the Text Messaging System. The mobile communication tools were used by learners on their mobile phones as an additional module for Moodle and were implemented by Java ME (Java Platform Micro Edition). Java ME provides a robust, flexible environment for applications running on mobile and embedded devices, such as mobile phones or personal digital assistants (PDAs).
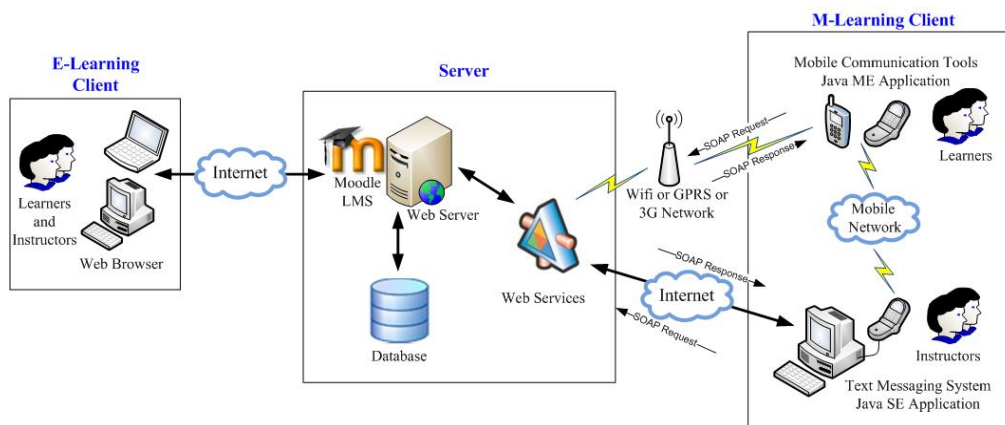
Figure 8. Architectural demonstration of the integration of the LMS with mobile communication tools and Web Services

As the second component, the Text Messaging System was used by the instructor to deliver messages to groups of learners via their mobile phones. Implemented by Java SE (Java Platform Standard Edition) technology, the system allowed messages, learners' names, and phone numbers to be retrieved from Moodle (see Figure 5 and 6). The system worked with existing plans on GSM phones attached to SIM cards and paid local operators per SMS, as usual. As a PC/laptop-based system, it was not on servers controlled by third parties. Consequently, the instructor could easily manage outgoing messages.

Server

In this study, the server consisted of three main parts: the Moodle LMS, database, and Web Services. Based on PHP language, the Moodle LMS uses a client/server approach, and all content of operations and functions exists

entirely in the server. The e-Learning client, a Web page created in HTML, acts as a gate to enable the browser to obtain user requests from the server. The course information contents are stored and managed using databases such as MySQL and SQL Server. The last component is an interface (Web Services) that maintains the communication between the LMS and the mobile communication tools, as well as between the LMS and the Text Messaging System. Web Services enable mobile client applications (mobile communication tools) and the Text Messaging System to access the LMS's contents and activities. Web Services are also responsible for translating the LMS's function requests into appropriate formats for mobile applications. An overview of Web Services is explained in the following section.

Web Services

Web Services is a software system designed to support application-to-application or machine-to-machine interactions over a network, constituting an infrastructure used for developing and deploying distributable applications. In addition, it allows software codes to be written in different languages and run on different operating systems. Other systems interact with Web Services through a URL described by SOAP (Simple Object Access Protocol) messages sent over accepted Internet protocols, such as HTTP. Clients access Web Services applications using XML (eXtensible Markup Language) messages that follow the SOAP standard through its interfaces and bindings, which are defined using XML artifacts, such as a Web Services Definition Language (WSDL) file (Singh et al., 2004).

As Web Services can run on a variety of software platforms, architectures, technologies, or devices, this study employed Web Services to provide information from the LMS to the proposed tools on mobile devices as well as to the Text Messaging System on a desktop or laptop computer. The study also used WSDL and XML-based language to describe Web Services. WSDL-based documents provide information about how to interact with the target Web Services, including a description of the Web Service, a method for accessing a Web Service, the location of a Web Service, binding information, and a way to exchange data by using a Web Service.
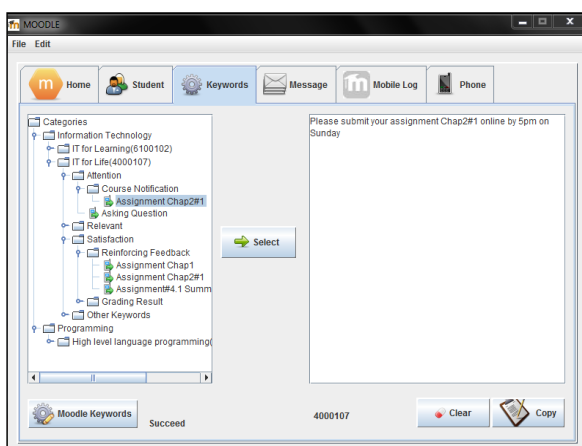
Figure 9. Selecting the course notification text message to learners
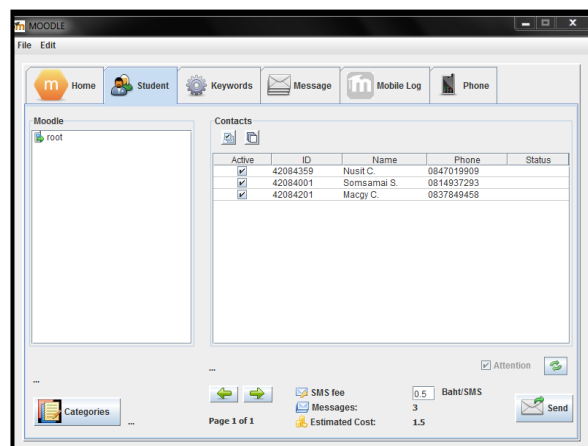
Figure 10. Retrieving the learners as they are texted from LMS

TOOLS EVALUATION

The main focus for evaluating the tools was to determine the learners' opinions and obtain learner feedback after participating in the study. Data for the evaluation were collected from questionnaires of how successful they were in supporting learning at the end of the course, forum discussions in the e-Learning system, and access logs of the m-Learning (mobile communication tools) and e-Learning systems throughout the semester. A pilot study was conducted involving 40 first-year undergraduate students who had taken the *"IT for Learning"* course through an e-Learning system in the first semester of 2010 in the Faculty of Information Technology at one university. The course was organized using a Moodle LMS with the proposed new tools. The participants' task was to log in to both the e-Learning and m-Learning systems to access the materials and interact with their peers and instructor. All students owned a mobile phone and could receive the text messages. However, only 15 students in this sample had a mobile phone supporting the Java platform to run and access all proposed tools,

The questionnaire was designed to gather information about the learners' perception of their learning experience, especially as related to the tools used during the online course. Questions focusing on the importance of the proposed tools were asked using a 5-point Likert scale with a tool not used rated as a 1, a somewhat important tool rated as a 3, and a critical tool rated as a 5. The questionnaires were distributed to the students, and 29 of them were returned. The overall results indicated that the learners found the proposed tools important for accessing

information and for communicating with peers and the instructor in online learning (3.21). The results from the survey are shown in Table 2.

Survey (*N* = 29)	Average	Std. dev.
How important is using the following tools in your mobile phone to supporting online learning? *1=not used, 3=somewhat important tool, 5=critical tool*		
• SMS	3.69	0.95
• Assignment Feedback Tool	3.44	0.63
• Performance Gradebook Tool	3.44	1.15
• Mobile Blogging	3.19	1.33
• Mobile Instant Messaging (MIM)	3.13	1.06
• Attendance Reporting Tool	3.00	1.10
• Mobile RSS feeds	2.94	1.29
• Mobile Polls and Votes	2.88	1.20
Background questions	*Percent*	
• Do you have a mobile phone?	100%	
• Can your mobile phone access the Internet?	88.64%	
• Can you install and run mobile communication tools on your mobile phone?	51.72%	

Table 5. Result from survey of tools evaluation

Throughout the semester, the total number of SMS messages sent to an individual learner with a mean of 29 (ranging from a low of 18 to a high of 32), or approximately two messages per learner per week. 38% of respondents said that they accessed the course website (e-Learning system) twice a week, while 27.6% and 17.2% said they accessed it once a week or less, and four times per week, respectively. The actual number of learner postings on the online discussion board, including comments or questions, was approximately three postings per learner per week.

Moreover, the students were asked to provide additional comments. They felt that they gained valuable experience in using the e-Learning system and its associated mobile communication tools. The majority of students saw value to be gained from the flexibility of accessing the course, sharing of ideas, opinions, and knowledge with their peers and instructor at anytime and from anywhere. The findings show that SMS has become one of the most popular and most effective means of communication in the online course. SMS is the only method of the proposed tools that touches 100% of participants. Obviously, SMS is push media that can distribute information, and can be customized for individual preferences.

CONCLUSIONS

This paper has discussed and demonstrated how to utilize mobile devices in online learning environments, mainly considered as an additional tool by providing learners with different methods of mobile communication to encourage motivation and engage in an online learning process. After analyzing the survey data and logs of access on the server, this study found that the proposed framework can assist learners in their learning process. The usefulness of various tools developed in this study for support-perceived learning depends on which learning activities the tools can support. In other words, instructional design for learning activities is necessary for selecting the appropriate tools to improve the learners' motivation for learning. Further research would be required to explore the relationship between motivation factors (ARCS and collaboration) and overall learners' motivation in an online course that is supported and non-supported by mobile communication tools so as to better understand their interrelationship and the effectiveness of the tools.

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Participatory design of a mobile application for teenagers' language homework

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ABSTRACT

In this paper we focus on the design, and in particular the design process of a mobile application for teenagers' homework in Swedish as a second language. We have used participatory design methods, with the aim to have a user-driven design process. The design process was iterative with several interventions with the students and their teachers. We discuss to what extent the design methods used and applied supports user-driven design. The analysis of the design process showed that it was not to be considered as fully user-driven but it is instead reasonable to consider it as a balanced design process, where the students' design work was essential for the final product. The application was used in two field tests. The field tests were evaluated using pre- and post questionnaires focusing on the attitudes and opinions of the students using the application for their homework. Results from the questionnaires showed that fully supported mobile learning activities are needed in order to achieve positive attitudes from the students towards using the mobile application for learning Swedish.

Author Keywords

Participatory design, teenagers, second language learning, homework, mobile learning, field testing, student attitudes.

INTRODUCTION

In this paper we describe and analyze the design process of a mobile application for teenager's Swedish language homework. In the project we have used participatory design methods, with the aim to have a user-driven design process. We wish to discuss how these design methods relate to the concept of user-driven design, and how the results of the design process are related to the participants, and their contexts. The final design of the application, called the Mobile study assistant, was evaluated using pre- and post questionnaires focusing on the attitudes and opinions of the students using it for their homework.

The current project was a collaboration between researchers, a mobile learning software company and an organization promoting Swedish culture and use of the Swedish language in Finland. The aim of the project was to increase the motivation for learning Swedish as a second language in Finland. Swedish used to be the official language in Finland, widely used by e.g. public authorities. Nowadays only a minority speaks Swedish even if it is an official language, alongside Finnish. Swedish is still an important language for many professional positions in Finnish society. However, the interest for learning Swedish has decreased in Finland. Swedish as a school subject has been under political discussion for quite a while now, and it is no longer a required subject in the final exams from upper secondary school. The development of a mobile application for Swedish language homework is one part of the promotion in order to enhance interest for Swedish. In addition, we have investigated if and how the students' motivation in learning Swedish changes when introducing a mobile learning tool in that activity.

A research and development team organized the main design process in the project. The design process involved 36 students, which were involved in the development of the application using an iterative design process via design workshops (Löwgren & Stolterman, 2004). The students participating in the workshops were in the age of sixteen to eighteen, engaged in the school subject Swedish as a second language in three secondary upper schools in different parts of Finland. The methods used for the workshops were inspired by the relatively long tradition of

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cooperative/participatory design (Greenbaum & Kyng, 1991). The general idea of using these methods was that they have been proved to be successful for extensive user involvement in software development. In the project three different workshops were arranged with the students. The development team worked with analysis and various design activities in between the workshops.

The study of the students' attitudes towards learning Swedish using the mobile application was carried out independently from the design process and the work of the development team. We will report the results of this study after describing the design process, and the analysis of it.

Research questions
With a focus on the design of the Mobile study assistant, and how much the students contributed, we formulated the first research questions as follows:

How user-driven was the design process when designing the Mobile study assistant?

In order to say something about how successful (or not) the design and its process was, we have analyzed the design process, but also investigated its outcome – the Mobile study assistant, the product, and the students' attitudes towards it when they were using it. From this a second research question was formulated:

Did the use of the Mobile study assistant have any positive effects on the students' attitudes towards learning Swedish?

DESIGNING FOR LEARNING
The concept of design is a rising concept in educational science, and it concerns several aspects and processes. One important movement is the so-called design-based research (The Design-Based Research Collective, 2003) emphasizes the relationships among theory, artifacts, and pedagogical practice. The design of artifacts does not necessary mean only digital learning environments, but a rich flora of materials. The design-based research perspective views educational interventions as interactions between teachers, students and materials.

This perspective is useful for interaction design of learning environments because it adds didactic design to the traditional processes of interaction design. We cannot ignore the very important fact that learning is the main design objective. We also have to relate to the fact that students' learning already take place, in many cases without any digital material. Students are already carrying out their language homework within the already established educational setting. So, what does digital technology, and mobile technology in particular add to these activities of learning Swedish as a second language in Finland? We will not give the full answer to these questions, but we will reveal a discussion of the issues with the teachers and students that were participating in the project.

The main research objective of the project was to create a user-driven design process, and carry out research about this particular process. This means that the workshops carried out might have been changed a bit during the design journey to the 'product', and also between the more or less repeated design workshops carried out in different schools in Finland. In other words, the design process of the artifact was more important than carrying out the design workshops in a strictly scientific manner. This might be seen as a challenge of doing research close to pedagogical practice.

Cooperative or Participatory design (Greenbaum and Kyng, 1991) meets the requirements of the design-based research methods, it is close to praxis, and it might involve both teachers and students. Participatory design has been applied to the learning area in several projects (see Druin 1999; Taxén et al, 2001). According to Mazzone, Read and Beale (2008), teenagers is more seldom a targeted group of users compared to children, at least in the last decade children have been forming its own area of interaction design research. How difficult is it to invite teenagers into the design process, and even let their ideas be the ones to develop? If learning is the main goal for design, how can we at the same time make the ideas of the teenagers prominent? These were important challenges for the design process.

How user-driven is user-driven design? We have used the analysis tools developed by Janet Read et al (2002) as a support for us to analyze and reflect on the participatory design processes during the design of the homework application. They use a model including different levels of participation, and contributions of domain experts in the design process: Informant, Balanced, and Facilitated design (IBF). Furthermore, we have used the IBF participatory continuum model and its variables *Environment, Knowledge, Skills*, and *Security* in order to analyze the details of our design activities. We think that this model will help us to analyze and reflect on our design activities, and put light on important issues when designing for learning.

Overview of design and research process
The project collaborated closely with three schools in different areas in Finland. This was a wish from the main stakeholder of the project, a Finnish organization promoting the Swedish language and culture in Finland. It was also important to get in contact with teenagers that have different language contact with Swedish, and also have different digital habits, especially with the focus on use of mobile phones. The students participating in the project

were chosen by the schools.

School 1: Northern Finland, 13 students participated. Swedish was the main language used to communicate with the students. One teacher who was attending the workshops translated Swedish into Finnish when necessary.

School 2: Western Finland, 14 students participated in the workshops. Swedish and Finnish was used to communicate with the students. No teachers participated in the workshops.

School 3: Southern Finland, 9 students participated in the workshops. Swedish and Finnish was used to communicate with the students. No teachers participated in the workshops.

In all workshops data were mainly collected via drawings and text written by the students. Video, photographs and notes were used as secondary data sources. Every workshop lasted for about two hours depending on other activities and the conditions in the schools.

Pre-studies
In order to get to know the field of homework, and the teachers' procedures about them, a questionnaire was sent out to teachers associated to the network of the main stakeholder in project. Nine teachers answered the questionnaire, and the findings were that homework in Swedish was given two to four times a week. A simple homework exercise concerned vocabulary and grammar, and a more advanced homework involved reading and writing. Homework was normally followed up by oral discussions in class.

Participatory design and prototype development
Two types of design workshops were carried out. The first was a Future workshop and the second focused on paper prototyping by the students. The results from the workshops were used as a very important material for the prototype development. PowerPoint-prototyping was used for communicating the design ideas with a pedagogical advisory board connected to the project as well as programmers. The mobile prototypes were developed using Java ME.

Prototype evaluation and product development
Students from the three schools evaluated the first prototype. A group of teachers evaluated a refined and further developed version of the prototype. After the workshop with the teachers a full-fledged version of the Mobile study assistant was developed.

Evaluation of the Mobile study assistant in schools
The Mobile study assistant was evaluated in a larger field test during the autumn of 2009, and in a smaller field test with one teacher and her students during the spring of 2010. Pre- and post questionnaires were used as a tool for investigation.

DESIGN WORKSHOPS AND PROTOTYPING
The future application that the development team had in mind at the beginning of the project was loosely defined as a mobile application for Swedish homework to the students. This was the frame, and the starting point presented to the students in a first series of workshops, which were conducted as a Future workshop following the line of Participatory design. The purpose of a Future workshop is to gather information about the users current situation, and their ideas of a future application suitable for their needs.

Future workshops
The future workshops started with a presentation of the project, its partners, and its future goals. We also introduced and discussed with the students the interplay between avail and joy in learning, and how it was important for the project to combine "business with pleasure", when learning Swedish.

After a short intro of the whole journey from the first workshop to product development (the Mobile study assistant), we started to discuss what learning a second language is about, what kind of knowledge and skills are necessary in order to use a language. We gave the students some time to think on the different aspects of learning Swedish by asking the question "How do you learn a second language?" After that we developed a mind map of language learning together with the students. The idea of this part was to visualize language learning, and put up the frame for the next step.

Following the Future workshop concept developed originally by Kensing and Halskov Madsen (1991) we started with a critique phase, in which the students should try to identify all problems they saw with the current learning situation, the future application, homework, and schoolwork on mobile phones. In order to frame the discussion even more we asked the following questions: 1. What is hard when learning Swedish? 2. What problems do you have with your homework? 3. How do you use your cell phone today? 4. What problems do you see with mobile phones and schoolwork?

After that, during the fantasy phase of the workshop, the students went from problems to solutions using brainstorming in small groups. Every student wrote one idea on a post-it note and they posted all ideas on one

large paper belonging to whole group. The brainstorming session ended up with a presentation of the different ideas for the whole large group.

As a last step they took some ideas further, and developed them into a language exercise that might work in a mobile phone. It was possible for them to borrow ideas from each other for the implementation step. We choose this as our implementation phase, and we did not at this moment exclude any of the ideas developed by the students. It was up to them to choose the most stimulating idea, and describe it in more detail.

Results

The workshop resulted in a "mind map" of language learning, and more than 100 ideas for how to learn Swedish using a mobile phone. Although the workshops was not an investigation of student's attitude and knowledge of learning Swedish, we dare say that they seem to have a quite good picture of what is necessary in order to learn a second language. There were differences between the student groups when discussing how to learn Swedish. Some students were more into learning the formal aspects of Swedish, while some other students also emphasized the cultural aspects when learning Swedish. However, as the project does not investigate these differences we will not dig further into this, but it says something about how different students are, and that we need to design for this.

Prototyping with users

After the first workshop, the design team analyzed the workshop material and matched it against realistic possibilities of mobile technology. The criteria used in the analysis covered technical possibilities and pedagogical aspects. This analysis resulted in eight design proposals:

1. Chat with language tools (dictionaries, grammar aids). 2. Different kinds of games with language focus. 3. Music with lyrics and language tools. 4. Text reader with language tools and exercises. 5. Personal profile. 6. Pronunciation practice. 7. Language tests – have I done my homework? 8. Discussion forum – a community for homework.

The second series of workshops started with a detailed presentation of how the students' ideas have been developed from the first workshop. The eight design proposals were explained, and we also carefully told the students what had been added by us as designers. We wanted to show the students that all their ideas had been useful, and that many of them were still in the design process. After this introduction, three design methods that we wanted them to work with were explained. The methods were: sketching, creating scenarios of use, and drawing and writing storyboards explaining the use of a design proposal. The large group was divided into three or four smaller groups.

Figure 1. Paper prototyping during one of the design workshops.

In the first session of the second workshop we let each group choose proposal, and we also instructed them to work with two proposals to get a good penetration of each design proposal. However, we changed this in the two following workshops, because it was a very demanding task for the students to work with more than one proposal.

Results

The workshop resulted in more knowledge about the students' views on how each design proposal could work in a mobile application for homework. After this the team started to create digital prototypes using PowerPoint, in order to get a better idea of the different concepts developed by the students. These prototypes were then used in our communication with programmers and the pedagogical advisory board, in the process where a prototype running on a mobile phone was developed.

USABILITY TESTING OF THE FIRST MOBILE PROTOTYPE

The third series of workshops were designed as a kind of on-site usability testing, with aim to test the first prototype of the application running on the mobile phone. The prototype was quite advanced, and was connected to servers in Sweden, carrying out some of the processing for the application. We started the workshop by explaining what had happened since we met the last time – how the design process had proceeded. We also told the students of the feedback from the pedagogical advisory board connected to the project. The students gave us many proposals that concerned different types of exercises during the design workshops, so we decided that it was unproblematic from that respect to include an existing vocabulary exercise software, called Learn, in the prototype. The new thing was that the function Learn now was connected to a news reader. The Learn function takes words from the texts read and create flash card exercises from it. The user can choose the language direction, i.e. Swedish-Finnish or Finnish-Swedish in our case.

The students were divided into groups (14 groups in total for all workshops), and they got one mobile phone per group to carry out the test with. They were instructed to take turns controlling the phone. They received a short manual for handling the application. They received six exercises on paper, handed out one by one to make sure that all groups were doing all exercises. Every exercise was covering one feature of the application:

1. **News reader** – the student can read Swedish news with this function, and use an integrated dictionary in order to look-up words for translations.

2. **Learn** – the student could make vocabulary exercises connected to the texts from the News Reader with this function.

3. **Music** – a music player with Swedish songs and lyrics as subtitles.

4. **Movies** – a movie player with a short Swedish film with subtitles.

5. **Chat** – a chat function that made it possible for the students to start chatting to each other.

6. **Search** – a search interface to a Swedish-Finnish dictionary.

Every exercise instruction was followed by several questions. In total, 20 questions had to be answered. Seven fields for other comments were also included in the exercise material given to the students.

Results

The results of the workshop gave us new insights into what students think are important when doing homework in a mobile application. One important conclusion was that the students wanted more exercises because of the fact that they felt uncertain if one really learn something just reading Swedish news papers or listen to Swedish pop music.

From the lessons learned from the usability tests more effort was put into the developing of a more elaborate application including for instance a grammar exercise engine, and more advanced content and interaction. We used this application in a meeting with a group of teachers, who had expressed interest in using the application in different schools. We let the teachers test the application, and we encouraged them to give us their reflections and comments of the new mobile application. After the meeting with the teachers, the development went into a final phase before the field testing of the application in ten secondary upper schools. This first field test in "the wild" was followed up with a much more supported field test in one school located in western Finland, reported below.

DESIGN PROCESS – REFLECTIONS

We will now analyze and reflect upon the participatory design process used during the design of the application. We will use the analysis tool, the participatory continuum model developed by Janet Read et al. (2002) in order to assist this task. According to the model, the participatory design can be described as a continuum with modes of Informant design, Balanced design and Facilitated design (IBF). The model focuses on the amount of participation by the design experts and domain experts. Informant design suggests informing role for the domain expert while design experts lead and realize the design. Balanced design suggests an equal partnership between the domain experts and design experts. Both parties inform and realize the ideas. Facilitated design suggests that the domain experts initiate ideas and lead realizing the design, while design experts facilitate the process. Read et al. (2002) point out that the amount of participation is not static, but may differ during the different phases of design activities.

Both the students and the teachers were recognized as domain experts in the project of mobile language learning. However, in the following analysis only the students are considered. In the project, the students' role and importance was taken into account from start while planning the research approach. The workshops were initiated and planned in order to facilitate the students' participation in the project. Their role was also stressed in the beginning of each workshop with them in without neglecting the role of designers. The actual activities varied as the project proceeded. In the beginning of the project, the students identified ideas and developed them further,

while towards the end of the project, the students evaluated and tested the prototype. Transparence of various activities was of importance during the process. For example, it was described how students' ideas were processed by designers and how they made their way through the process.

To put it in Read et al. (2002) terms, the process could be categorized as balanced design. The aim was to recognize the domain expert as equal partners with design experts. Both students' and designers' work was essential for the design process. However, it is the design experts that both lead and realize the design. Further, we should keep in mind that the overall aim, learning, as well as decisions on what ideas could and would be developed further, were taken solely by the design team based on various aspects (pedagogical, technological, economic etc.). This indicates power. The various participants might be considered partners, however they are not equal.

Read et al. (2002) have also identified four variables that affect the position of the group; *Environment*, *Knowledge*, *Skills* and *Security*. Environment refers to both cultural and physical environment in which a participatory design activity takes place. Read et al. (2002) argue that aspects such as room, furniture, seating arrangement and culture and structure of the organization as well as relative status of the participating individuals may affect the activities. Knowledge refers to various types of knowledge each participant brings into the design activities and that affect how the participants view their own and others ability to contribute to the participatory design activities. According to Read et al. (2002) cognitive skills, motor skills and articulatory skill will affect the individual's ability to contribute to participatory design activities as well as functionality of the group. Further, also the individual's feeling of security will affect how people contribute to participatory design activities.

The workshops in the project were carried out at the particular school sites. The school environment as a physical site and an organization framed also the workshop activities. The workshops were carried out in ordinary classrooms at two schools, while a conference room was used for the purpose in one of the schools. The tables in the rooms were rearranged in order to make group activities possible in smaller groups. Obviously, the rooms had a certain size and furniture and therefore made only partial changes in seating possible. However, workshops equipment such as pens and papers as well as fruit, candy and drinks suggested a somewhat different setting than the ordinary. The school environment suggests certain expectations between students and adults, such as adults being in charge and what would be suitable behavior between them. The environment advocates formal learning activities rather than informal ones. The students participating in the workshops knew each other or at least knew of each other. Many of them took the same classes.

Knowledge the students brought into the activities included familiarity with the task, learning a language. They were also familiar with mobile phones. One of the classes was specializing in information and communication technology, which also was shown in the discussions and suggestions they made using technological terminology. While cognitive skills, motor skills and articulatory skills or rather, the lack thereof might be crucial while working with young children, however, this was not at stake here. Students had no difficulty to take part of the given instructions, carry out the tasks and present and discuss results with others. Even though they were not familiar with a design project per se, the workshop activities included familiar activities such as drawing, writing and presenting.

THE FINAL PRODUCT AND ITS EVALUATION
The final version of the Mobile study assistant was further developed after the meeting with teachers in the beginning of the autumn of 2009. The final version was improved in several aspects based on the feedback from the teachers. The final version excluded some of functions from the prototype versions, but also added new functionality based on feedback from students and teachers.

Figure 2: The Main menu of the Mobile study assistant to the left. The two other screens show a grammar exercise based on a sentence from a text from the News reader. The interface of the exercise is based on the idea of flash cards, and self-evaluation. The grammar exercise for the student is to answer the question: What is the inflected form of the word given its base form?

The main menu of the Mobile Study Assistant consisted of (see Figure 2): **Teacher's texts ("Lärarens texter").** The teachers could upload texts to a server, which only their student's have access to using the Mobile study assistant. **News Reader ("Nyheter")**: was an improved version from the prototype version, it was now also possible to listen to some of texts. The News reader was connected to the dictionary, and to vocabulary and grammar exercises (see Figure 2). **Music ("Musik")**: was an improved version of the music player, in which the student could listen to music with or without subtitles. **Dictionary ("Ordbok")**: Improved interface to the dictionary. **My words ("Mina ord")**: The student could save words that he/she felt were difficult, and later carry out exercises with them. **Preferences ("Inställningar")**.

The field tests and students' attitudes

The students' views on the Mobile study assistant were investigated with two questionnaires, which they answered both before and after the first field test in the autumn 2009 and in the spring 2010. The selection of informants was done on convenience basis – they were the students whose Swedish language teachers had volunteered for the project. All the informants were Finnish speaking students who have been studying Swedish 2–8 years, depending on their age and stage of language studies. In the autumn 2009, altogether 112 students answered the pre-questionnaire and 97 answered the post-questionnaire. A little over half of the informants were senior high school students, one third vocational school students and the rest upper level comprehensive school students. According to the informant's answers to post-questionnaire, only 59 of them had been using the Mobile study assistant one or more times, whereas others had not been able to because of technical problems. The test was therefore repeated in the spring 2010 with a group of senior high school students. This time the functioning of the Mobile study assistant was guaranteed by providing compatible mobile phones to all students. The group of informants, which answered the survey, was considerably smaller this time, as 9 students answered the survey before the test and 15 after the test. This time four of the informants reported that they had been using the assistant once and four not at all during the test period.

The two questionnaires consisted both times of three types of questions: multiple-choice questions where students were asked to give only one answer that they prioritize, multiple-choice questions with several options on a Likert scale of 1–5, and open questions where students could freely write about their views. Both questionnaires included questions about the students learning and motivation, attitudes to teaching of languages and Swedish particularly, and about their opinions of the homework given. In the pre-questionnaire, there were also questions about the student's background and earlier studies, use of languages (Swedish particularly), and their expectations on the Mobile study assistant. The post-questionnaire included respectively questions about the student's experiences with the Mobile study assistant and their views on using it in studying Swedish. The goal of the questionnaire was to let the students tell their opinion about using the Mobile study assistant and to find out whether the use of Mobile study assistant eventually could be proved to have a positive effect on student's attitudes towards Swedish language and studying Swedish language at school.

The answers to both pre-questionnaires show that most of the students had very positive expectations for the tool, and they looked forward to try it. Many of the students seemed to have expectations about the experience in itself.

They expected to experience something new considering the methods of learning and wished that it would make studying Swedish easier, more interesting, pleasant and motivating. Some of the students expressed concrete expectations about the assistant's effect on language learning, and wished for increased learning results, e.g. better knowledge of the Swedish vocabulary and grammar. Nevertheless, there were also those who did not expect anything special. The answers also show that the students are used to carrying their mobile phones with them, and the new idea of using it in studying seemed thus like a natural idea for them.

The informants that answered the first surveys in the autumn 2009 form a heterogeneous group considering motivation to study Swedish language, study success and use of Swedish language outside school. On one end of the scale there are those who consider Swedish as an interesting and important school subject, talk Swedish regularly with their relatives or friends, visit Swedish web pages and get good grades in Swedish and feel good about their own language proficiency in Swedish. On the other end of scale are those who are not interested in Swedish and think that it is a pain to have the compulsion to study the language, do not ever use Swedish outside school and report that they get low grades in Swedish and estimate their own language proficiency in Swedish to be low. Compared to the larger sample, the small group of students who answered the survey in the spring 2010 estimated their language proficiency in the pre-questionnaire to be poorer than the group from the autumn 2009, but seemed to have a slightly more positive attitude to Swedish (note that the data is not qualified for statistical significances). Neither of the two groups gave more positive answers considering Swedish language after the test with the Mobile study assistant. It should be noted that though the results can be explained in both groups by the short test period (6–8 weeks). Motivation and attitudes are long term phenomena, which are on the one hand problematic to measure, and on the other hand are permanent and change very slowly (Dörnyei, 2001).

According to the answers to the first post-questionnaire (autumn 2009) students reflected on the technical problems with the internet connections and the compatibility with some mobile phone models, and quite many of them could not use the tool or could only try some of the provided functions. Those who did it criticized the degree of difficulty of the provided texts and exercises, which were experienced to be too easy especially by the senior high school students. The study shows though that the weaker students (those who themselves give low grades for they language proficiency in Swedish) seem to evaluate the test with the Mobile study assistant higher than the students with better language proficiency in both groups. The biggest difference between the two groups can be seen in student's evaluations of the Mobile study assistant after the test. The larger group from the autumn 2009 gave in general lower grades to the Mobile study assistant than the smaller group from the spring 2010, where technical support and loaned mobile phones were provided. The smaller group agreed on that it was nice to try the Mobile study assistant, and they could think of using it also in other language studies and would like to continue using it in studying Swedish. They felt that they have gotten enough guidance in using the assistant and think that the assistant works well. All these statement got negative grade in the larger group who experienced technical problems.

CONCLUSIONS

Important here has been to analyze the participatory design process. Even though our users, mainly the students, were part of the process and participated in great deal, it would be too much to say that the process was driven by them. The analytical model, as any other model, gives form to the certain analytical outline, but also leaves out others. The model focuses on the design activities in situ, what actually happens during a certain activity, such as a workshop where the suggested domain experts are present. However, a connection to a broader context would also be needed. By looking beyond the certain activities, we can move analysis to bridge the gap between individual (but not any particular individual) and context.

From the questionnaires we can see that compatibility problems caused by real life use of very different mobile phones is an obstacle for mobile learning activities, and that the attitudes towards mobile learning changed when the activities were fully supported. According to the answers in the questionnaires it can be concluded that the students enjoyed using mobile phones in language learning, presupposed a decent technical functionality and a right level of difficulty of the provided material.

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Designing Content-Independent Mobile Learning Technology: Learning Fractions and Chinese Language

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ABSTRACT

The paper describes a framework for content-independent collaborative mobile learning along with the two content-specific applications built on top of it. The technical architecture provides mechanisms for computer-based collaboration that facilitates face-to-face collaborative mathematics and Chinese language learning activities in a primary school setting. We present the theoretical underpinnings of our approach, the software and research design in both mathematics and language learning, as well as the outcomes of a series of preliminary trials. The experience from the trials has been used to propose a new cycle of the system and user interface re-design, and research design.

Author Keywords

mobile learning, computer supported collaborative learning, mobile language learning, software architectures

INTRODUCTION

The mobile technology is bringing a new facet to the theory of computer-supported collaborative learning (CSCL) (Zurita & Nussbaum, 2004), by making collaborative learning activities more dynamic, personal and flexible. In that sense collaboration happens on the move and is integrated with the personal character of mobile devices providing a platform for communication, collaborative problem and project-based learning. However, some studies report the drawbacks of mobile device use (Sharples, 2003) claiming teachers are challenged to tap this technological enabler in their classrooms and to come up with lesson activities that genuinely integrate mobile devices into curriculum and lesson plans (C. K. Looi, et al., 2009) (Roschelle, Rafanan, Estrella, Nussbaum, & Claro, 2010; Shen, Wang, Gao, Novak, & Tang, 2009).

In our attempt to better integrate mobile devices into everyday classroom practices we present a design for collaborative mobile learning which spans across two dimensions: technological and social, and has the following characteristics: (a) the software system enforces collaborative rules in the technological dimensions therefore supporting face-to-face activities in the social dimension; (b) the technological dimension allows for the use of diverse content types (in other words it is content-independent); (c) the technological dimension can be reused for different content types (e.g. mathematics, language learning etc.) and (d) the teacher is able to utilize the technological dimension in order to provide scaffolding to participating students.

Two content areas have been implemented and used in trials with primary school children in Singapore: Chinese language and mathematics learning. For each of the content-specific activities, we have conducted a series of trials informing us on the following: user interface design, system performance and, finally, our research design. The mobile collaborative technology, students' existing personal relationships and the teacher's facilitation together provide collaborative scaffolding to the students. Based on the empirical findings, we can plan more thorough series of trials with a redesigned user interface, enhanced system characteristics and a more adequate research design.

THEORETICAL BACKGROUND: MOBILE COLLABORATIVE LANGUAGE LEARNING

One of the biggest misconceptions regarding computer supported collaborative learning is that "the social interaction happens automatically" (Kreijns, Kirschner, & Jochems, 2002; Stahl, Koschmann, & Suthers, 2006). It is now known that for collaboration to happen, it is not enough to assign students to groups and

provide them with computer-based assignments (Johnson & Johnson, 1998). Some team members might experience difficulties in communication, coordination and interaction with other team members (Curtis & Lawson, 1999), mostly because of the lack of visual contact and body language. Therefore, the real strength of computer supported collaborative learning does not lie in the collaboration around computers, it happens through computers and computer supported social networks which benefit from peer experience (Haythornwaite, 1999; Inkpen, Booth, Klawe, & Upitis, 1995).

Independence of time and location together with the potential of supporting interactive team members' communication make mobile computer supported collaborative learning the next logical step in the research and the development of the area of collaborative learning (Cole & Stanton, 2003). By using mobile devices, learning becomes personal since every student has his or her own mobile device. Mobility, flexibility and the fact that mobile devices are always available to students make ad hoc collaborative activities possible. A key research in that area covers the use of mobile devices in the education of children six to seven years old (Zurita & Nussbaum, 2004). Children were given assignments that had to be completed through collaboration with the certain level of interaction and communication exhibited in the process. Authors reported that the use of wireless networks opened up new educational opportunities and that mobile communication devices enhanced certain components of collaborative learning (Kreijns, et al., 2002).

Each Chinese character comprises of one or more components which are spatially arranged according to certain principles (Liang, 2004). Most of the components have fixed roles, as either a semantic component or a phonetic component (e.g., a character with the component 氵 is very likely to carry a meaning relevant to water or liquid, e.g., 河 = river, 湿 = wet); only a few of them play both roles. Zhao and Jiang (2006) proposed that there are 10 basic spatial configurations for characters (see Figure 1).

Studies (e.g., Wang, Perfetti, & Liu, 2003; Zhu, 2004) have indicated that those who have learned Chinese characters recognize them mainly based on their structural elements such as graphic forms and spatial configuration, treating each character as a salient perceptual unit. Tan and Peng (1991) also argued that analyzing the 3-dimensional characteristics (spatial configuration, semantic element and graphic form) is the necessary route leading to the effective recognition and reading of characters, i.e., the ability to attend the visual-graphic form is crucial in learning characters.

1 (木)　　2(安)　　3(案)　　4(对)　　5(树)　　6(获)　　7(想)　　8 (程)　　9(新)　　10(国)
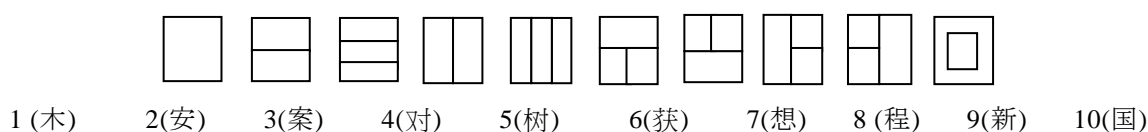
Figure 1: 10 basic spatial configurations for Chinese characters

Informed by the language acquisition theories (e.g., Comprehensible Input (Krashen, 1985), Information Processing (Bialystok, 1978), and Connectionism (Gasser, 1990)) and Bloom's Taxonomy, the researchers argue that there are six steps in acquiring Chinese characters, namely in hierarchical order: comprehension, combination, memorizing, application, analyzing, and creation. The fact that a limited numbers of semantic components and phonetic components can form a large number of characters leads the researchers to argue that learning characters through rearranging and combining their components in different positions is cognitively effective, as it allows learners to comprehend, remember and apply the principles of character formation.

CONTENT-INDEPENDENT LEARNING TECHNOLOGY MODEL

A variety of studies in the field of mCSCL (mobile Computer Supported Collaborative Learning) have explored opportunities for designing learning applications through networked mobile technologies (e.g., Liu & Kao, 2007; Yin, Ogata, & Yano, 2007; Zurita & Nussbaum, 2004). In our approach we propose a technological solution (a framework) for delivering collaborative in-class (and potentially out of class) activities. This is a generic solution able to support diverse content types therefore being content independent. This is achieved by a clear separation of learning content and the generic collaboration rules and actions which can then be used with different kinds of content. In this paper we present two types of content used in this system: mathematics and Chinese language content, both delivered to students through the framework in collaborative manner (Figure 3).

The collaborative scaffolding from the social and technological framework dimension can be applied to different learning content, such as learning fractions, composing sentences, or forming Chinese characters or idioms, by using the same set of social and technological collaborative rules and technological communication mechanisms. The system considers any mobile learning content as the sequence of content

elements that can be combined in a sensible unit, and distributes the elements (either generated automatically or as provided by the teacher) to students. In our software design, activity rules are content-dependent and are enforced both by the designed technology and through collaboration with teachers and peers.

Content dependent activity rules are defined for each mobile learning application. The fractions activity comes with rules which determine how to combine fractions (by summing or some other operations), what makes a whole or a solution, how to generate fractions prior to distributing them in order to have feasible local and global group goals and how to introduce complexity when generating fractions (such as having larger denominators). Conversely, in the collaborative activity of forming Chinese characters, the basic content elements are components which are arranged spatially to form legitimate Chinese characters. The rules of this activity define different graphical layouts of Chinese characters, check whether a combination of Chinese characters produces a valid character and check the semantics in case there are more feasible solutions than initially predicted.
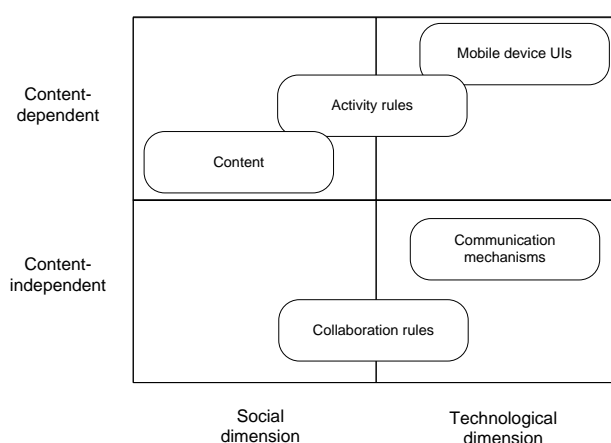
Figure 3. A two-dimensional matrix positioning the main design components in the socio-technological content-driven landscape

SOFTWARE ARCHITECTURE FOR MOBILE COLLABORATIVE CONTENT-INDEPENDENT LEARNING

Following the recent developments in the field of information technology, the physical system architecture is designed to be modular, extensible, object-oriented, and multi-layered. Main parts of the system are libraries called frameworks: the Base Framework, the Device Framework and the Server Framework. The latter two are built upon the Base Framework to provide services to specific parts of the system. The Desktop Framework is used by the applications for desktop computers (in our specific case teacher's console application); the Device Framework by the client applications and its applicative modules (in our case fractions and Chinese language mobile learning applications) while the Server Framework provides the base for the Contextual Information Service, Event Service, System and Applicative Services (Figure 4).

Applicative services are used by the applications installed on mobile connected devices and are commonly used as interface to the central system data repository. Applicative services are mutually independent and do not influence the operation of server services in any way which makes them easily extendable and replaceable, even during the normal system operation.
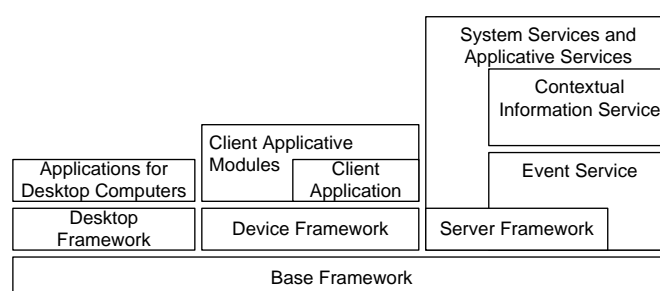
Figure 4. Framework's physical architecture stack

Base Framework is composed of sub-modules designed for communication between the server and the clients, structuring and assembling event messages (Boticki, Mornar, & Hoic-Bozic, 2009). This library is composed of specially designed controls called widgets which are used to implement contextual features of the system: privacy, spatial, contextual, configuration and communication-identification widgets. All of them are used to exchange contextual information between mobile connected client devices and server components. Base Framework contains basic building components extended by the Device Framework and Desktop Framework in order to support platform specific activity.

Server Framework is a component based on the Base Framework which provides services to higher-lever server components. Server Framework assembles and sends event messages, receives client response messages, and manages configuration, location and contextual widgets. These widgets process contextual information on the server side before it is handed over to the module for contextual information to be stored in the database or to be further handed over to the module for event sending. The module for contextual information is used to receive contextual subscription and contextual requests for event message sending (Figure 5) (Boticki, et al., 2009).

MAKING USE OF CONTENT-INDEPENDENCE: TWO MOBILE LEARNING APPLICATIONS

Learning Fractions (FAO)

In FAO-supported activities each student has a handheld device with the preinstalled framework and FAO application. Once FAO is launched, students' handhelds report to the centralized server side component via available network connections (e.g. WiFi or 3G). As soon the teacher starts the fractions learning activity, fractions are delivered to students' devices (Figure 7.) and students are free to start collaborating in order to complete the task of assembling circles out of individual fractions.
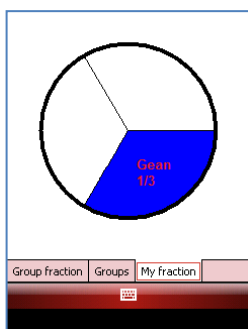
Figure 7. A fraction assigned and displayed on a student's mobile device
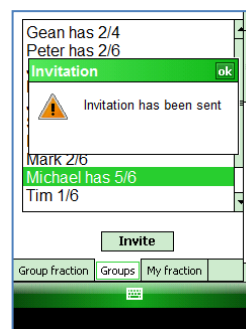
Figure 8. Student issuing a group invitation to his classmate

Students begin collaborating both on the social and on the technological dimensions in order to come up with a solution. Socially, they circle around the physical learning environment and communicate with their peers in order to negotiate a common solution. They refer to the FAO mobile application containing the list (Figure 8.) of their peers and, once a potential solution is negotiated, they invite a colleague to form a group. Students collaborate and form groups by adding (merging) fractions until they come up with fill circles (wholes).

Prior to the assignment of fractions to students, the server-side component runs a fractions generation algorithm which ensures that there is a global solution, namely, at least one possible solution in which every student belongs to a group and every group has a full circle. Although the random fraction distribution ensures fraction diversity, the teachers can control the type of fractions distributed therefore structuring and fine-tuning the activity.
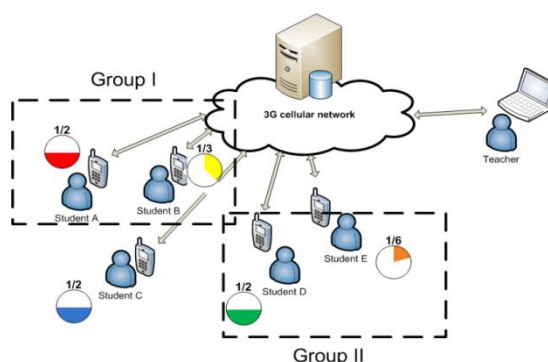
Figure 9. A group configuration of an impasse preventing students from achieving the global goal

Local optimum presents a formed whole circle within a group. Although optimal for a group, it might not be optimal for all groups. Some groups might be blocked in reaching their local optimal solutions because one group reached a certain local optimum. The group then has to be broken and other groups have to be assembled, hopefully leading to optimal solutions for all groups which in turn lead to the completed activity.

Learning Chinese Language (Chinese-PP)

The second application is called Chinese-PP, PP referring to 拼一拼 or "Pīn yì Pīn" in Chinese, which roughly means "trial assembling". Similar to the fractions game, a set of Chinese components are assigned by the system server via available network to individual students' handhelds. Students are required to form groups by choosing appropriate components forming valid Chinese characters. During the process of character forming, members of each group have to decide on an appropriate Chinese character template (character configuration) supplied by the Chinese-PP application (arrows < and > in Figure 10). For example, with the components 覀, 示 and 风, students could decide to choose template no. 9 (Figure 1) and place the components in the correct order to form the character.

In preparing each round of the game, the facilitator (e.g., teacher) needs to select a set of components according to the number of participating students and input them to the system. The choice of components should allow the construction of as many eligible characters as possible, and with at least one global solution (i.e., no component/student will be left out) available. For example, for a game with eight participants, a possible component set is [木 又 寸 宀 女 禾 口 王], where students could form three groups and construct the characters [树 安 程] or [案 对 程] without any player being "left out". However, there exist other combinations such as [宋 对 和], with 王 and 女 being left out (there is no character with the combination of these two components), and a lot more.
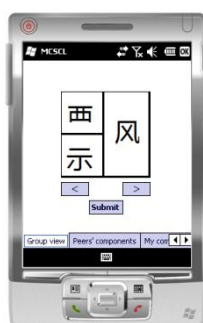
Figure 10. Chinese-PP application user interface enabling character composition

Figure 11. Chinese-PP application showing student and their characters ready to be invited to groups

During the activity the teacher is presented with a view of its technological dimension. All assembled groups and template-arranged characters are depicted and ready to be shown to participating students if a need for additional scaffolding occurs (Figure 12). For example, students should be enticed to compose more complex characters, help their peers by disbanding existing groups and forming new groups etc.
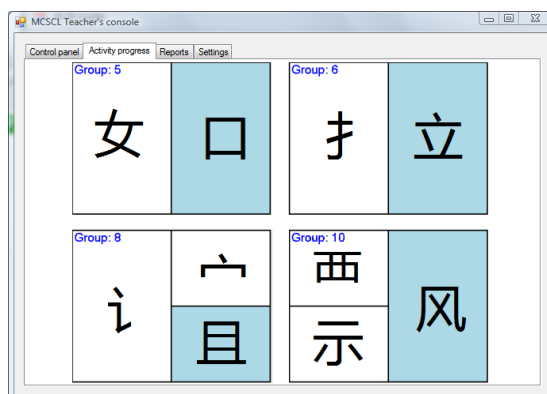
Figure 12. Chinese-PP teacher's console showing assembled groups and Chinese characters

EXPERIENCE FROM USING FAO AND CHINESE-PP IN PRELIMINARY TRIALS

Both applications, FAO and Chinese-PP were evaluated in a primary school under the bigger context of a three-year school-based study "Leveraging Mobile Technology for Sustainable Seamless Learning" (C.-K. Looi, et al., 2010) conducted in Nan Chiau Primary School in Singapore. The study essentially re-designed the curriculum and the lesson plans so they can be delivered in a "mobilized" way. This means not only appropriating learning contents so that they fit mobile devices, but also encompasses the redesign of complete learning environment which becomes more collaborative, contextual and inquiry-oriented.

Conducted Trials

FAO and Chinese-PP present two specific interventions within the project focusing and promoting in-class collaboration between mobile students. Several trials were conducted per each application in order to gather the data about general user experience, system performance, user interface design and to set off a new cycle of system redesign.

A pilot study on FAO was conducted in late 2009 that involved 16 Primary 3 students (Boticki, Looi, & Wong, 2010). One important finding was the students' modification of their initially chosen ad-hoc strategies (e.g., gender or personal preferences, looking for the same fractions, randomly sending out invitations, etc., which inevitably ended with impasses) coming as a consequence of them realizing the importance of achieving the global goals besides their local group goal, therefore learning how to collaborate (e.g., breaking out groups for improved solutions).

Based on the same framework Chinese-PP trials with 37 P4 (10-year-old) students with mixed ability were commenced in 2010. In this round of trials students participated in the two main activity modes: card and phone mode. The card group mimicked the Chinese-PP application design and served as the control group in the subsequent comparisons (Table 1). There were two subgroups in total: Subgroup A with 19 students: card game + phone game; and Subgroup B with 18 students: phone game + card game. The activity was followed by the focus group interviews.

	Day 1		Day 2	
Subgroup A	Card game A-1	Focus group FA-1	Phone game A-2	Focus group FA-2
Subgroup B	Phone game B-1	Focus group FB-1	Card game B-2	Focus group FB-2

Table 1. Experiment design for the Chinese-PP activity trials

A paired-samples t-test was conducted to evaluate the impact of the intervention on 4E students' scores on the Chinese language test. There was a statistically significant increase in scores from Pre-test (M=8.45, SD=2.580) to post-test (M=12.95, SD=4.544, t(31)=-5.721, p<0.0005). The eta squared statistic (0.52) indicated a large effect size.

A New Cycle of System Redesign

Throughout the conducted trials there were some occurrences of degraded system performance. This was especially noted in the first trial attempts with FAO with large groups of students participating in the activity. Students first started using the system cautiously but after they got acquainted with it they gradually applied trial and error strategy by issuing multiple invitations to their peers. This produced a large number of invitations some not being answered by the receiving parties which resulted in long waiting time and eventually resulted in disrupted activity as students' interest shifted to more informal learning scenarios.

The invitation-reply system proved to be a bottleneck in the Chinese-PP activity as well, but not in as significant manner as in FAO due to activity's more flexible design (students are able to experiment with character formation even if some of the peers haven't accepted their invitation to join the group). Analyzing the number of exchanged messages during one of the Chinese-PP trials with N=12 participating students we come up with a surprisingly high number of exchanged event messages NE = 317 during less than 5 minutes of activity duratio. This certainly does not impact our system's performance itself, but in case of deadlocks (i.e. one student does not reply) usability issues arise.

According to our experience we propose a completely new user interface design which in turn makes the whole request-reply philosophy simpler while utilizing the same unchanged framework just with another set of event (communication) messages. In the new design students now have two Chinese-PP applications screens. On the first application screen (Figure 13) they have an overview of all participating peers and are able to drag and drop peers' components onto a centrally positioned canvas. This in turn automatically creates groups on the second screen (Figure 14) which can then be confirmed after grouped students achieve mutual agreement. Each choice is supplemented by a number of points a group gets after it gets accepted.

Figure 13. A sample of the new UI design – common area for character assembling

Figure 14. List of all potential groups ready to be chosen by the students

The presented approach reduces the complexity of the technological scaffolding by simplifying initial Chinese-PP UI design. There is no functionality loss due to the reductions applied and students will presumably benefit from a more adequate user experience.

CONCLUSIONS

This paper presented architecture for content-independent collaborative mobile learning, software design and implementation and the preliminary trials leading to a new cycle of both system and research re-design. Drawing from the theories of computer supported collaborative learning and language learning, the system scaffolds students in collaborative activities around concrete content bits: either Chinese latter components or mathematical fractions. Through collaboration on both technological and social levels, students come up with solutions to teacher-set tasks. Technology provides scaffolding in the sense of both content-dependent and content-independent software features or affordances, while the teacher acts as facilitator and helps the students in dealing with impasses. Social scaffolding is encouraged in order to increase student interaction and collaboration

To examine the effects of our interventions we designed trials with the two applications for Chinese language learning and mathematics learning. Through the trials in mobile mathematics learning (FAO) we explored the notion of collaborative scaffolding consisting of three components: social, technological and teacher scaffolding. We observed occurrences of negotiation, peer instruction and generally collaboration beyond physical and social boundaries. We continued our effort by designing a Chinese-PP application for learning Chinese characters. Our experiment design was taken to a new level by having included a card group as a control group into our experiment. The card group mimicked our software design and allowed us to closely examine its drawbacks learning to a new cycle of software redesign.

As the next step we venture into a new cycle of research, software and intervention design. We plan to embed the approach into regular primary school Chinese language lessons as a full-fledged study and examine its effects on a long-term basis. Our software will be redesigned to fit new technologies and UI design principles. By using it, students will be able to take their own individual paths in learning while, on the other hand, be guided by an automatic scoring system keeping track of their achievements.

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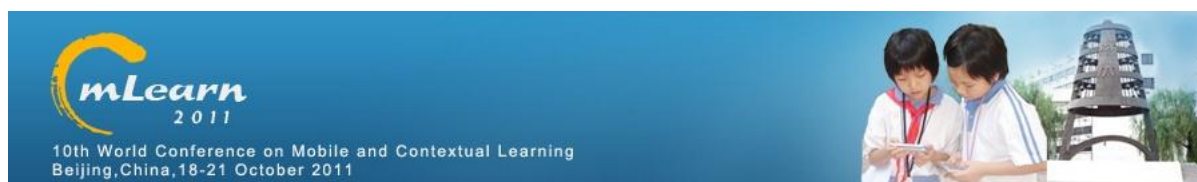
Exploring the MOOC format as a pedagogical approach for mLearning

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ABSTRACT

This paper takes a look at the MOOC format as a possible pedagogical approach to fit mobile learning (mLearning) based on mutual affordances of both contemporary learning/teaching formats. The paper presents a case study of how MobiMOOC, a course created using the Massively Open Online Course (MOOC) format, demonstrates the synergistic characteristics between the MOOC format and mLearning, making a combination of both fields ideal for contemporary, digital, collaborative learning and knowledge construction. MobiMOOC was a six-week online course focusing on mLearning that ran in April and May 2011. MobiMOOC was freely available and saw 556 learners join the supporting Google Group. An end-of course survey provides insight that supports the synergies between MOOCs and mLearning. The paper zooms in on the time and location independency, contextual learning, collaborative learning, the potential of interdisciplinary information exchange and contemporary technology for learning online e.g. social media, mobile devices.

Author Keywords

Mobile learning, mLearning, MOOC, connectivism, collaborative learning, OER

INTRODUCTION

Since 2005 the rise of mobile devices, social media and learning that is facilitated by new mobile and social technologies has grown exponentially. This rise of new educational forms (both from a pedagogical and a technical point of view) has resulted in a quest for new learning methodologies and frameworks. This paper reconciles a new learning format, the Massive Open Online Course (MOOC), itself based upon connectivism (Siemens, 2004), with the contextualized nature of mobile learning (mLearning).

We live in a rapidly changing world. These changes affect us all. "Since the scope of the change exceeds personal and interpersonal learning activities to include larger scale organizational and societal change, additional theories are needed to explain change, to plan interventions and to develop policies" (Bell, 2011).

The design of learning with and using mobile and wireless technologies, mLearning, is still exploratory as mentioned by Kukulska-Hulme and Traxler (2007). They proceed saying that if mobile technologies are used to support 'informal, personalized, situated mobile learning' then the learning designs are much more likely to be exciting, innovative and challenging" (p. 190). mLearning has not yet been tested in relation to connectivism. However, these two emerging phenomena have some interesting similarities. As Downes states, networks in which people are engaged in dialogue can be small or vast, but the main characteristics for networks to support knowledge development will be that they are "diverse, open, autonomous and connected" and this fits the informal, personalized characteristics relating to mLearning (2007). So, if mLearning is time and location

independent and contextualized, then is it possible that the pedagogical format of a MOOC fits these specifics? In this paper the authors link mLearning and the MOOC format.

The following sections describe the research methodology, provide an overview of MobiMOOC design, describe the results of the MobiMOOC survey, make connections between connectivism and mobile learning, and finally provide recommendations for future research.

RESEARCH METHODOLOGY

This is a case study based on the design and implementation of MobiMOOC, a six-week MOOC on the topic of mobile learning. Data collection included the design of the MobiMOOC course itself, statistics and content from the social media tools (Google Groups, Twitter, Delicious, Crowdmap) and a survey given to participants of MobiMOOC at the end of the course. The survey comprised a series of 12 questions designed to determine general demographic information, familiarity and use of technology and social media, participant satisfaction with the course, preconceived notion of what type of learner participants would be in the course, and actual level of participation.

The collected data was analyzed to validate the hypothesis that mLearning, connectivism, constructivism, and the MOOC format share mutually beneficial characteristics. These characteristics work well in the new knowledge society where informal lifelong learning is a valuable asset for knowledge workers. The authors are both participants as well as researchers from the MobiMOOC.

In accordance with the vision of a MOOC in which you construct knowledge collaboratively, this paper was written jointly with the MobiMOOC participants that volunteered.

MOBIMOOC DESIGN

From 2 April to 14 May 2011 MobiMOOC, a six-week MOOC format course on mobile learning, was organized by Ingatia de Waard, who also remained present throughout the course. The course was free to anyone interested in the topic of mLearning, fitting it within the idea of Open Educational Resources (OER). After completion of the course the content was available via open source content resources. Although most resources offered by the facilitators and participants were openly accessible online, some of the academic resources, such as peer reviewed papers in academic journals, were behind paywalls.

MobiMOOC was offered over a course of six weeks with each week organized thematically and facilitated by leading mobile learning researchers and practitioners. The content of MobiMOOC included an introductory session to the MOOC, mLearning planning, mLearning for development (M4D), leading edge innovations in mLearning, interaction between mLearning and a mobile connected society and mLearning in K-12 environments. All the facilitators were *guides on the side*, each putting forward as many learning actions and follow-ups as they wanted, as each of these facilitators was voluntary engaged in this course.

All participants (including the facilitators) were free to receive new information and construct new knowledge that fit their own personal mLearning needs. As such, participants were in charge of their own learning. The participants were able to get information that was relevant to them by asking the entire group for their insights.

The course organizers suggested three categories for learner participation, hoping to convey the importance of self-regulated learning to the participants. The three types were:

Lurking participants participated in a variety of ways: just follow the course, look at the recordings, and browse the available course resources. The benefit to the lurking participant was to get some idea of what is going on in the field of mLearning.

Moderately active participants took one or two topics and engaged in the conversation with everyone involved. The benefit for the moderately active participants was that they developed more in-depth knowledge in that area of mLearning and were able to exchange notes and expertise, getting answers to questions the participants may have had.

Memorably active participants participated in at least five of the six topics. They developed an mLearning proposal in their area and received peer and expert help. Although a template for the individual project was provided, it was clearly communicated that the writing of the proposal would be done by each of the participants. Memorably active participants received a certificate of participation.

The end result was a course with a variety of participants and levels of participation. More representation from developing nations that are facilitating tremendous innovations in mLearning would add depth to the dialogue.

MOBIMOOC SURVEY RESULTS

By 14 May 2011, the end of the course saw the following statistics:

556 participants joined the Google Group, of which 13.3% (n=74) were active members, with active membership being defined as those who posted at least one message in addition to their introduction.

1827 discussion threads were started.

1123 tweets were sent with the #mobimooc hash tag.

335 mLearning related links were shared on the social bookmarking site Delicious.

43.2% of the active participants (n=32) completed the course as memorably active participants.

53% of the active participants (n=40) completed the end of course survey.

Although a MOOC is a fairly new educational format and mLearning is still mainly seen as a technology rich field, MobiMOOC participants showed diversity in both age (21-30=15%, 31-40=22.5%, 41-50=25%, 51-60=27.5%, 61-70=10%) and gender (male=57.5%, female=42.5%) which could indicate that the format attracts people from across the traditional dichotomies (see figure 1).
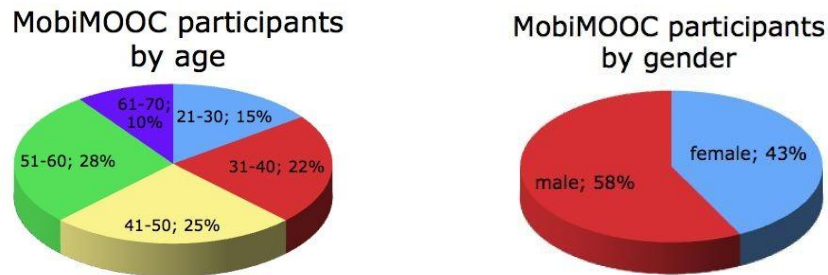
Figure 1, participants per age and gender group

One remarkable result was that 65% of the active participants reported that they did indeed work on a personal project. Additionally, 82.5% of active participants indicated that they did indeed make use of what they learned in MobiMOOC in their own local settings, pointing to the fact that knowledge acquired during MobiMOOC was directly applicable and beneficial to the advancement of participant's learning in the mLearning field.

Although the participants were not required to access materials via mobile devices, 77.5% of them chose to. Participants indicated the reasons they preferred to use their mobile devices to access the course materials. The predominant factor was the location independence afforded by mobile devices (61.3%). Participants did not need to be tied to a desk in order to participate, rather they could participate wherever they we located. Closely tied to the location independence is the temporal independence (56.8%). Participants could access materials at a time and place that was convenient for them. In addition, participants used mobile technologies to access the course because they could (29.5%): it was an option and participants choice to use it.

There were, however, restrictions to using a mobile device, the chief reason centering on mobile device usability and user interface. The major reasons were the screen size of mobile devices (72.5%), the lack of a physical keyboard (65%), and the perceived device functionality (57.5%); a device, for example, may lend itself much more to read-only functionality than read-write functionality. Other factors that were important to participants when deciding when to use a mobile device were the cost of mobile data plans (25%), their speed when compared to traditional Internet connections (32.5%), and, as is usually the case, habit (30%).

When the MobiMOOC participants were asked whether they thought a MOOC could be followed entirely via a mobile device, 55% answered positively. The close results may indicate that following a MOOC via mobile devices is a matter of device preference.

The use of social media is central to a MOOC. As such, the participants in the course used a variety of web-based tools. The initiator of the course choose to centralize the course around two major web-based spaces: a MobiMOOC Google Group (http://groups.google.com/group/mobimooc/) and a MobiMOOC wikispace (http://mobimooc.wikispaces.com). Both were also marked with a RSS link to allow people keep informed on the latest developments. The Google Group was set-up to centralize discussions, while the course wiki was set-up to function as an online syllabus. Other social media spaces, such as YouTube, Twitter, Facebook, and Delicious, were used throughout the course for sharing specific content. In addition to the official MobiMOOC web-spaces, some of the participants added other spaces during the course. Examples of these are the MobiMOOC Crowdmap (http://mobimooc.crowdmap.com/), the MobiMOOC LinkedIn group, the MobiMOOC Posterous blog, and the Zotero MobiMOOC group. The MobiMOOC content on these social media tools was in many cases also accessed with mobile devices.

MERGING MLEARNING AND MOOC

When looking at the learning related characteristics of both mLearning and MOOCs, similarities between both emerging learning methods surface, which we will put forward here.

Background on MOOC

The concept of a MOOC was first introduced by Stephen Downes and George Siemens as they were building a course format to fit with the theory of connectivism: this course came to be known as *Connectivism and Connective Knowledge* (CCK08). "In connectivism, the starting point for learning occurs when knowledge is actuated through the process of a learner connecting to and feeding information into a learning community" (Kop & Hill, 2008, p. 2). Kop and Hill went on to state: "connectivism stresses that two important skills that contribute to learning are the ability to seek out current information, and the ability to filter secondary and extraneous information" (p. 2). Mackness, Mak and Williams (2010) find that when the theory of connectivism is situated in the practice of a MOOC, its network principles of diversity, autonomy, openness, and emergent knowledge are comprised.

The format of a MOOC is by definition open and online. In order to allow as many participants as possible to join the course, de Waard chose to use resources that were accessible via the Web. In addition to their accessibility, these web-based spaces were screened for their accessibility via mobile devices. The definition of mobile devices in this case includes: smartphones, iPads (and other tablet devices), netbooks and laptops. This option was taken to allow participants to immediately use mobile devices to access the course materials, and thus adding to their mobile experience. However, the course was not intended to be delivered solely via mobile devices, because if only mobile devices were used (1) this might have limited the accessibility for people with a preference not to access learning material or discussions via mobile devices; and (2) we wanted to enable participants without mobile devices, but who would be interested in exploring mLearning, to actively participate in the course.

How mLearning relates to MOOCs

Though MobiMOOC started out to simply deepen the understanding of mLearning, as the course preceded similarities between mLearning and MOOC characteristics arose.

There are a variety of mLearning definitions, but during MobiMOOC an adapted mLearning definition as described by O'Malley *et al.* was used: participants took mLearning to be "any sort of [technology enhanced] learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies" (2003).

 "mLearning has attracted a great deal of attention from researchers in different disciplines who have realized the potential to apply mobile technologies to enhance learning" (Özdamar Keskin & Metcalf, 2011, p. 1). This focus on learning within mobile technology driven learning is only just emerging. "Early definitions of mobile learning were too technocentric and imprecise … they merely put mobile learning somewhere on e-learning's spectrum of portability" remarks Traxler, essentially selling mLearning short. Laurillard (2007) makes a strong point by mentioning that "the point of turning to new technologies is to find the pedagogies that promote higher quality learning of a more durable kind than traditional methods" (p. 158). The authors of this paper feel that the pedagogical format of a MOOC is a worthwhile pedagogical approach to combine with mLearning precisely because it explores new pedagogies (ie, Connectivism) which promote a higher quality of learning than traditional formats, especially in light of the affordances of these new mobile technologies (e.g. across location and time).

MOOCs allow learning to happen across space and time due to its mainly asynchronous and online architecture. This is very similar to mLearning characteristics. Due to the pervasiveness of the use of mobile devices in society, connecting to a community across space and time is becoming a fact: "Mobile phones have created "simultaneity of place;" a physical space and a virtual space of conversational interaction, and an extension of physical space, through the creation and juxtaposition of a mobile "social space." This affects people's sense of time, space, place and location, their affiliation's and loyalties to groups and communities, the ways in which they relate to other individuals and to groups, their sense of their identity, and their ethics" (Traxler, 2010, p. 2). But the same can be said of social media, which drive MOOCs, and the rise of ubiquitous learning. Due to the use of social media by MOOC participants, learners in particular, can surpass time and space. The MOOC participants also become part of a community with its own identity and dynamics. According to Siemens, learning is now happening "through communities of practice, personal networks, and through completion of work-related tasks" in an environment in which "know-how and know-what is being supplemented with know-where (the understanding of where to find knowledge needed)" (Siemens, 2005, p. 4). mLearning facilitates this know-where understanding of knowledge by connecting learners, information, and tools at a point and time of the learner's choosing. When looking at these characteristics mLearning and MOOCs fit well together, but there is more.

The idea of connectedness is not limited to propagators of MOOCs or Connectivism, but has been mentioned by mLearning researchers as well. Traxler (2010) mentioned that the "learners' experiences of knowing and learning … are changing with the experience of greater mobility and connectedness" (p. 13).

When describing mLearning, Winters (2007) also listed three interesting aspects: mLearning enables knowledge building by learners in different contexts, it enables learners to construct understandings, and the context of mobile learning is about more than time and space. Indeed the same can be said about learning through a MOOC. A MOOC surpasses time and space as all the resources are centralized in the cloud accessible for those who are willing (and technologically able), it fits the learners' context(s), and it enables knowledge construction. Like Bell (2011) said: "knowledge can be viewed as residing in networks of humans and non-human appliances, whilst leaving space for human agency".

However, as both emerging learning methods are based on technology and accessibility, they do have a similar challenge as well. Technology, social media, and Internet access (whether via mobile devices or computers in general) is still not a global reality. There is still a digital divide that keeps knowledgeable people from a weaker socioeconomic background to take part in this learning shift. This is an important challenge to tackle in the future.

In short, when looking at mLearning and MOOCs one cannot help but see similarities in its time and space autonomy, the community that is built, and the contextualization that takes place by the fact that everyone brings their experience to the center of the learning community. Connecting is now possible across time, space and contexts. mLearning, connectivism, and its practical format the MOOC, fit these new contemporary facts.

mLearning and MOOC: Setting Up Communicative Dialogues

While looking at mLearning and MOOCs, it is clear that even though knowledge can be seen as residing in both humans and non-human appliances, it is what we do with that knowledge, and how we construct new knowledge, that is important. This is where a Vygotskian perspective is quite useful. According to Vygotsky (Nassaii & Swain, 2000), knowledge is social in nature and is constructed through a process of collaboration, interaction and communication among learners in social settings; this we saw happen in MobiMOOC time and time again. Through a process of collective scaffolding (Lantolf & Appel, 1994) participants assisted other participants in MobiMOOC to expand their understanding of mLearning, and in some cases also helped them implement personal mLearning projects. In many cases participants received constructive feedback on mLearning projects that they were either implementing or designing. This collective scaffolding enabled participants to work within the zone of proximal development (ZPD) (Vygotsky, 1978), to expand their capabilities with the help of more knowledgeable peers. In order for this to happen, dialogue must take place.

"The rapid development of technology and exponential growth in the use of the Internet, along with the Web 2.0 and mobile developments, make new and different educational structures, organizations, and settings a possibility" (Kop & Hill, 2008, p. 9). But due to all these societal changes, the dynamics between people are becoming more complex. As knowledge societies are becoming more of a reality, that complexity reaches the field of learning and education as well. Garrison pointed out "the need to make sense of complexity is compounded in the context of distance education" (p. 13). He continued to write that "this adaptability in designing the educational transaction based upon sustained communication and collaborative experiences reflects the essence of the postindustrial era of distance education" (p. 13). Communication, or dialogue, and living through experiences in a collaborative way are central to the idea of a MOOC. And although many voices raise the fact that with the rise of technology, complexity is growing too, there is one human factor that is now more than ever possible across borders, beliefs and time… dialogue.

"Mobile technologies are redefining models of learning that often rest on a Socratic or dialogic base" (Traxler, 2010, p. 13). This adds to the idea of Sharples (2005) who said that learning is a conversation in context. This emphasis on dialogue and conversations is also mentioned by Siemens (2008) who wrote that learning and knowledge "rest in diversity of opinions" (Kop & Hill, 2008). He also emphasizes the strength of interdisciplinary knowledge by stressing that "the ability to see connections between fields, ideas and concepts is a core skill".

As a MOOC is a gathering of people with generally no prior connection, it has a unique social advantage that relates to a more open and connected way of thinking. As such the authors underline the idea expressed by Freire and Macedo: "I engage in dialogue because I recognize the social and not merely the individualistic character of knowing" (p. 48). This also coincides with what Downes wrote on that the learning "activities we undertake when we conduct practices in order to learn are more like growing or developing ourselves and our society in certain (connected) ways."

Dialogue is also at the center of constructing or gaining knowledge, for "dialogue is the primary mechanism for maintaining connections and developing knowledge through them" (Ravenscroft, 2011). Where a MOOC is an ideal place for dialogue to take place and as such for knowledge to be constructed or appear, the same is said to be true for mLearning as written by de Waard and Kiyan "with mobile devices the learning environment is enhanced and ability to share knowledge through online discussion is strengthened through social media. The

sharing of experiences in a network facilitates the transformation of learning outcomes into permanent and valuable knowledge assets" (2010).

Due to the fact that one of the core content spaces was a Google Group, which promoted discussions, dialogue was at the core of MobiMOOC. In the final survey it also became clear that although there was a wide diversity of backgrounds within the participators of the MobiMOOC (health professionals, K-12 teachers, corporate training managers, language teachers, etc.) 92.5% of them indicated that they learned from mLearning ideas and insights from participants in other fields of expertise.

Learning is not a linear process; it is a continued iteration which links to prior knowledge, but that knowledge can then be modified after evaluating new information and analyzing it to that previous knowledge. As such learning and knowledge are in a constant state of flux. This fluctuating state of knowledge is even more emphasized in informal learning, for the learner is taking his or her own interpretation and testing it on the ideas of the other participants of learners. In MobiMOOC this sharing of new ideas was clearly not limited to the course participants. The new information and ideas were taken out of the course as well, and tested in other learning networks including with face-to-face colleagues (67.5%), with virtual (online) colleagues (77.5%), with friends (50%), with family (35%), and with classmates (25%).

When asked in what way information was shared, a mix of face-to-face, mobile phones, and social media dialogues were mentioned, again pointing to dialogue as a core feature of learning in any face-to-face or digital world.

The fact that dialogue is a core aspect of both communication and learning results in the idea that the MOOC format could also benefit other communities due to its open and human nature of constructing new knowledge as well as its very human characteristic of connecting to peers. This idea is strengthened by the fact that 90% of the participants indicated that they believe a MOOC format is appropriate for their learning communities.

How mLearning and MOOCs Strengthen Lifelong and Informal Learning
We, as global citizens, learn all of the time, but we are not always aware of our learning. Informal learning happens depending on the context we are in and the learning needs we consciously or unconsciously perceive. As we move through life, we transfer our insights and beliefs from one experience to another abiding by the flux of life and knowledge itself. In contemporary society we only value learning when it can be categorized with reference to frameworks of academic disciplines that we recognize as 'knowledge' or when it can be 'certified' (Coffield, 2000; Sutherland *et al.,* 2001). "Web-enabled learning is undertaken by individuals as independent, informal learners, often within social settings" (Bell, 2011, p. 100).

MobiMOOC (as well as other MOOCs) crystalized informal learning and made it possible to see that learning was happening in an informal setting. At the end, the participants acknowledged that they were able to use what was learned during the MOOC in their own formal setting (see figure 2). Hence knowledge was built in an informal way and transposed into the formal or professional realm. This is an interesting shift when compared to the more traditional education or training where knowledge is mostly formed in a formal way and stays there.

MobiMOOC was an informal course as there were no educational institutions linked to the course. The certification was also informal, as the certificate of participation was given to the memorably active participants. As such MobiMOOC is an interesting method for informal learning taking place ad hoc or over time. This ability to fit informal learning is also recognized in mLearning. Mobile and wireless technologies seem very well suited to learning that has been variously described as informal, opportunistic, 'bite-sized' and spontaneous (Colley and Stead, 2003; Bull *et al.,* 2004 – as cited by Kukulska–Hulme and Traxler, 2007) and also 'disruptive' (Sharples, 2005). Naismith *et al.* (2004) have demonstrated that mobile technology can relate to six different types of learning: behaviorist, constructivist, situated, collaborative, informal and informal learning and support or coordination of learning and resources. From these types of learning two can immediately be linked to the MobiMOOC dynamics: collaborative learning and informal and lifelong learning as previously mentioned in this article.

mLearning and MOOC: Connecting to People
We have seen that dialogue is at the core of the MobiMOOC, and that informal learning occurs. But these two dynamics cannot happen unless real connections occurred between real people, the participants of the MOOC. Connecting to people, networking amongst each other, is essential for learning to appear. In the connectivist model, a learning community is described as a node, which is always part of a larger network. A network is comprised of at least two nodes linked in order to share resources (Downes, 2007). As such all the participants to this MobiMOOC are nodes that are connected. A MOOC (and in particular this MobiMOOC) can be thought of as a "short-term" community of practice. All the participants are brought together to share community, domain knowledge, and practice for a short period of time. The community of practice lasts longer than the course itself, as activities continue (e.g. writing a paper) beyond the scope of the initial course. As a community

of practice, there are different levels of participation and everyone shares tools related to practice in a common network.

Downes (2007) stresses the importance of networking and especially the way in which we are each part of multiple networks. Downes stated that "knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks." As such, a successful, connected/networked pedagogy would "seek to describe the practices that lead to such networks, both in the individual and in society." Did networking really occur and were new connections formed during the MobiMOOC course? New connections did occur and not only by connecting to one another during the course, but it also resulted in 42.5% of the participants taking the final survey indicating that they connected to other participants in order to collaborate on projects after MobiMOOC.

FUTURE RESEARCH
The gender and age diversity does indicate that the MOOC format appeals to people across the traditional (and possibly flawed) dichotomies of gender and age, or that the people participating in MOOCs are well into their professional careers, perhaps indicating a general level of "seriousness" about the goals at hand. Further research is needed to see whether MOOCs or informal learning are attracting a specific learner profile that is not linked to age, gender or cultural background, but rather to factors in intrinsic and extrinsic motivations. In addition, two important categories were not mentioned in the final survey: race and social-economic status. It would be very revealing to see the ethnic breakdown as well as the socio-economic breakdown of participants in a MOOC.

MOOCs have a high enrollment of participants at the start, but they also have a high percentage of non-active participants, and a high dropout rate. Some of the non-active participants can be lurkers, who still find that following the course from the sidelines adds to their knowledge. The reasons behind this dropout or non-participation need further research.

The retention rate after a MobiMOOC is of interest, as after this course closed, the network between the participants remained active indicating that the efficacy the participants feel towards the MobiMOOC community has more strength than previously anticipated.

As mLearning is more present then computer based learning in many developing regions, it would be worthwhile to explore the MOOC format in combination with mLearning in developing regions to overcome the lack of trainers in these regions.

Finally, MOOCs are still evolving, each with its own format and underlying design priorities. Investigation into which design principles encourage dialogue, encourage retention, and lead to MOOC success would be beneficial.

CONCLUSIONS
With this paper the authors wanted to move away from the focus on technology, the main focus of mLearning in the past, and research its specific learning potential especially when combined with the format of a MOOC. mLearning and the MOOC format have a great potential for informal and lifelong learning. Both learning forms allow for knowledge creation to happen over time without being tied to a particular space and contexts. The growing importance of collaborative learning is supported by mLearning, constructivism, connectivism and its practical implementation the MOOC by all of their ability and focus on communication, more specifically dialogue, to construct knowledge and create collaborative networks. This new knowledge age demands new formats and frameworks to be drawn up, like McLuhan stated, "it is the framework which changes with each new technology and not just the picture within the frame" (McLuhan & Zingrone, 1997, p. 273). When looking at the shift in learning which is happening as a result of the rise in social media, ubiquitous cloud computing and new technologies, a MOOC complements all these changes and mLearning offers the devices and characteristics to realize such changes.

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iPadagogy: Appropriating the iPad within Pedagogical Contexts

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ABSTRACT

In this paper we compare and critique four mlearning projects using iPads in 2010. Using an action research methodology the authors explored the impact of the integration of the mlearning projects on the pedagogical approaches of these four courses. The four iPad projects present four different approaches to the integration of the iPad within a variety of educational contexts. The four projects were informed by six critical success factors identified from thirty mlearning projects between 2006 and 2010, and the resulting plans for 2011 are introduced.

Author Keywords

iPad, Pedagogy, mlearning

INTRODUCTION

The iPad has ignited interest from educators who see the potential of the iPad's affordances over laptops or smartphones. Is this just another case of the latest tool fever or as Brown-Martin (2010) describes an actual "game changer" for education? This paper explores the potential impact of the iPad upon tertiary education by comparing and critiquing four 2010 iPad project case studies. The common foundational pedagogy guiding the design of each of these projects was social constructivism, focusing upon student-generated content and student-generated contexts. The iPad was used as a "game-changer" by enabling teacher-centric learning environments to be disrupted by empowering students with devices that are portable, wirelessly connected, feature long battery life, and integrated with web 2.0 services for student-generated content, collaboration and sharing. Thus to varying degrees the four iPad projects used the iPad as a catalyst for pedagogical change, illustrating how mlearning can be used to help bridge the Pedagogy-Andragogy-Heutagogy continuum (Ecclesfield & Garnett, 2010; Garnett, 2010; Luckin, et al., 2010).

The Emergent iOS Economy

Apple has progressively developed an entire 'ecosystem' supporting its foray into the mobile market since the introduction of the first iPod in 2001. Ten years on this ecosystem now encompasses not only portable digital media players and the iTunes music store, but now includes the largest mobile application, music, and video revenue. The 2011 iOS economy encompasses a range of mobile devices including the iPod, the iPod Touch, the iPad, and the iPhone. Apple has built up a significant lead over competing mobile ecosystems (Android, Blackberry, Symbian, Windows Phone7, WebOS) in developing a mature mobile ecosystem. Whitney (2011) quotes Jack Kent, an IHS mobile media analyst, "Apple, in contrast, has been able to maintain advantage by leveraging its tightly controlled ecosystem--combining compelling hardware and content with the capability to offer consumers a trusted, integrated, and simple billing service via iTunes" (Whitney, 2011, p. 1). While Apple is often decried for making this iOS ecosystem tightly controlled and closed, the more "open" Google-owned Android mobile ecosystem has been playing catch-up and recently suffered a spate of malware attacks within the Android Market (Kirk, 2011). The Android Market, the equivalent of the iTunes App Store, is reportedly vulnerable to over seventy types of malware (Browning, 2011). Getting the best out of the Android ecosystem currently remains the domain of power users capable of tweaking and updating the OS to get the best out of it. In contrast, Nokia's Symbian ecosystem was recently described by its CEO as a "burning oil platform" (Ricknas, 2011), resulting in a partnership with Microsoft's Windows Phone 7 OS that has yet to attract significant market share. In comparison, the iOS ecosystem presents a maturing, safe and user-friendly environment supported by over 75000 apps, making it the popular mobile platform choice in education. However, the iOS economy is not without its foibles, chief among these is the restrictive file structure imposed upon iOS apps that requires application developers and users to develop creative ways of sharing content and data between applications, often

relying upon cloud-based services. Thus the iPad projects presented several limitations and challenges for the researchers' to mitigate.

Research Context

The researcher has managed and implemented almost thirty mlearning projects between 2006 and 2010. The focus of these mlearning projects has been on exploring the potential of mlearning as a catalyst for transforming pedagogy from instructivist lecturer-directed pedagogy to social constructivist pedagogy enabling student-generated content and student-generated contexts (heutagogy). The mlearning projects encompassed nine different tertiary courses, forming nine case studies spanning from one to four years of implementation and refinement, utilizing a range of wireless mobile devices (WMDs), and involved a total of 690 participants. The learning contexts included:

- Bachelor of Product Design (2006 using Palm Lifedrive, 2008 using Nokia N80, N95, and Apple iPhone 3G, 2009 using Nokia XM5800, N95, N97, 2010 using student-owned laptops and cameraphones, and Nokia N97)

- Diploma of Landscape Design (2006 Using Palm TX, 2007 using Nokia N80, 2008 using Sonyericsson P1i, 2009 using Dell mini9 netbook, 2010 using Nokia XM5800)

- Diploma of Contemporary Music (2008, 2009 using iPod Touch, iPhone 3G, 2010 using Apple iPad)

- Bachelor of Architecture (2009, using Nokia XM5800 and Dell Mini9 netbook, 2010 using Android HTC Desire smartphones and Apple iPads)

- Bachelor of Performing and Screen Arts (2009 using Dell Mini9 netbook and Nokia XM5800, 2010 using Dell Mini9 netbook, Nokia XM5800, and Nokia N97)

- Bachelor of Business (2010 using Apple iPad)

- Bachelor of Computing (2010 using Apple iPhone)

- Bachelor of Graphic Design (2010 using Nokia XM5800 smartphone)

- Bachelor of Civil Engineering (2010 using Apple iPad)
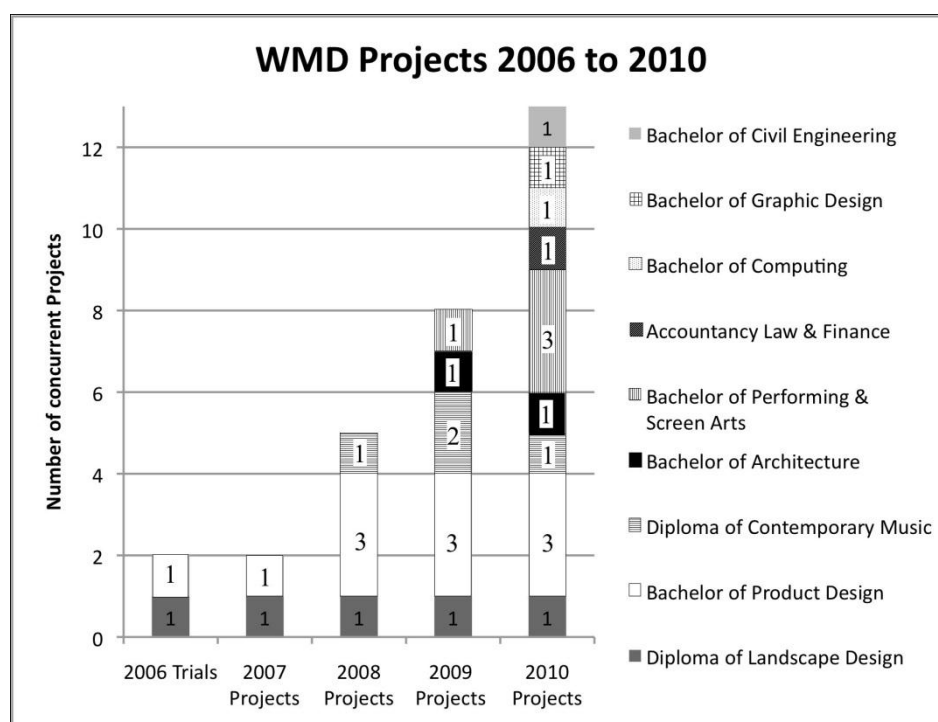
Figure 1: Mlearning Projects 2006 to 2010

Research Methodology

The research involved a partnership between the researcher, the course lecturers, and the students involved in each successive mlearning project. The researcher's role was that of the primary collector of data, and the technology steward (Wenger, White, & Smith, 2009; Wenger, White, Smith, & Rowe, 2005) within the communities of

practice developed to support each project. The research approach was thus participatory action research (Wadsworth, 1998).

Data Collection

The core data gathering tools used in this research consisted of:

1. Pre-project surveys of lecturers and students, to establish current practice, expertise and experience.

2. Post-project surveys and focus groups, to measure the impact of the wireless mobile computing environment, and identify emergent themes.

Lecturers and students recorded their reflections via their own blogs and eportfolios during the project, which were collated by the researcher via RSS feeds. The research used the technologies that were an integral part of the projects, such as participant blog posts, peer blog comments, and VODCast reflections to capture data on the progression and impact of mobile web 2.0 on the participants' learning experiences.

OVERVIEW OF THE IPAD PROJECTS

The four 2010 iPad mobile learning projects formed action research cycles within the longitudinal study into mobile learning at Unitec, utilising the mlearning pedagogical design and support framework developed throughout the earlier projects (Cochrane, 2010a, 2010b). The WMD projects (2006 to 2009) identified six Critical Success Factors for the implementation of mobile web 2.0 (Cochrane, 2010b, 2010c). The six critical success factors include:

1. The pedagogical integration of the technology into the course and assessment.

2. Lecturer modeling of the pedagogical use of the tools.

3. Creating a supportive learning community

4. Appropriate choice of mobile devices and web 2.0 social software.

5. Technological and pedagogical support.

6. Creating sustained interaction that facilitates the development of ontological shifts, both for the lecturers and the students, bridging the pedagogy-andragogy-heutagogy continuum (Garnett, 2010; Luckin, et al., 2010) from lecturer-directed pedagogy to student-directed heutagogy.

These were used to inform the development of the 2010 iPad projects with a focus upon the pedagogical integration of mobile web 2.0 within the courses and the establishment of supporting communities of practice that met regularly throughout the length of a semester.

First Year Bachelor of Business

In semester 2 of 2010 the first iteration of the Bachelor of Business project took place. The project took place in a first year Information Systems course spread across two streams of approximately 30 people each. Students of the day stream were given iPads to work with over the duration of the course and students of the night stream were given netbooks. The mobile devices were integrated into all class sessions and their use outside of class was strongly encouraged. The classical lecture was replaced with class sessions that involved a variety of activities, all of which were integrated with the mobile devices. A typical session involved brief presentations from the lecturer, involving class interaction through the use of polls. These presentations were mixed in with a series of activities where the students were at the centre of the learning, dealing with real world problems and creating their own solutions and content.

Students were encouraged to use the mobile devices to access and store a range of class materials including PDF handouts and eBooks with embedded audio and video. Students were given access to the course text book in eBook format as the main reference for the course. While both the iPad and the netbook were capable of storing and displaying the book, the iPad proved to be easiest to read, navigate and annotate. The course also involved a large number of handouts and exercises that traditionally were either printed or PDF based combined with videos. These were converted into iBook compatible eBooks with embedded video files making it very easy for the day class students to view the material wherever they wanted it.

The Mindmeister collaborative mindmapping online service was used regularly throughout the semester. It worked well with both the iPads and the netbooks allowing the students to work together on problems both during the class time and outside of class. Students engaged well with this and in many cases spent much more time on the activities outside of the class than they otherwise would. Blogging was also used throughout the course. Students initially used the Vox platform and then moved their blogs to the Wordpress platform after Vox shut down. The blogs were based around five assessed blog posts relating to the mobile devices and various aspects of the course. Students were also encouraged to blog between these summative posts and a number chose to do so.

Over the semester students were supported via a Moodle course designed with materials and activities encouraging interaction. Students made use of forums and glossaries to support each other and to gain support from their lecturer. In addition to this virtual layer of support a weekly face to face meeting was available for students to interact with their community specifically about using their mobile device for learning.

Business Education Affordances of the iPad
Example affordances of the iPad utilized in the Bachelor of Business mlearning project are outlined in Table 1.

iPad Capability	Supporting Social Constructivist Pedagogy	Example Application of Affordances
eBooks	Background reading that formed the basis of class discussions	Individual access to material enabling students to be informed in their interaction with each other.
Polling	A springboard for generating class conversations	Gathering and sharing of student thoughts, questions and answers. www.polleverywhere.com.
Blogging	Peer critique and collaboration via commenting	Student ePortfolio creation. www.wordpress.com
Mind Mapping	Concept linking and sharing of learner-generated content (Bruns, 2008).	Student idea creation and sharing.

Table 6: iPad business pedagogical affordances.

eCV Third Year Bachelor of Architecture Elective

The 2010 Architecture project was preceded by a larger but less successful mlearning project in 2009 using netbooks and Nokia Xpressmusic 5800 smartphones with second year Architecture students. The 2009 Architecture mlearning project illustrated the importance of leveraging the unique affordances of WMDs and of their use within collaborative learning environments (Cochrane & Rhodes, 2011). Consequently a different approach was taken in 2010 to establishing an Architecture mlearning project. The third year elective course was previously a lecturer taught course on how to create an electronic CV (curriculum vitae) using Flash and HTML. This elective course was rewritten as a collaborative project between the researcher, the course lecturers, and the course students. The 2010 eCV mlearning project involved the use of HTC Desire Android smartphones for student-generated content and student-generated contexts, and the iPad for editing and sharing this content, within the context of a third year Bachelor of Architecture elective course. The course was modeled on an intentional community of practice (COP) (Langelier, 2005), with the participants consisting of the researcher as the technology steward (Wenger, et al., 2009), the course lecturers, and the course students. The goal of the course was twofold: 1. To stimulate student-negotiated group projects involving student-generated content and student-generated contexts resulting in a foundational web 2.0 eportfolio that the students could then continue to build upon throughout the rest of their course, and 2. To create a group of students and lecturers within the Architecture Department that would then become educational technology evangelists, drawing in the rest of the Architecture lecturers and students from the periphery of the community of practice, thus using the integration of mobile web 2.0 technologies as a catalyst to transform the embedded pedagogy of the Architecture Department. Architecture education is traditionally modeled upon an Atelier studio-based approach where students work in physical group spaces, guided by an expert lecturer, and culminating in face-to-face presentations of their designs critiqued by their lecturers. The goal of the eCV course was to facilitate a move to a heutagogical learning environment, that is: student-directed, collaborative, flexible, context-bridging learning environment that empowers students as content producers and learning context generators, guided by lecturers who effectively model the use of the technology.

The eCV elective course consisted of weekly COP meetings where the participants investigated the unique affordances of the smartphones and iPads. Following this the COP met for a week-long intensive planning session during the semester break to formulate the student project plans. Students established four teams and brainstormed project concepts using a Twitter hashtag collated and presented live to the whole group using Twitterfall stimulating further discussion and ideas. The student groups then spent two days dispersed throughout Auckland City establishing their projects. They used the smartphones to capture geotagged photos and videos, and digitally augment the real world with augmented reality applications such as: creating points of interest for augmented reality browsers Wikitude and Junaio, QR Codes, and Google Maps. Media captured via the smartphones was then collated and edited using the iPads while on location, previewed using mobile laser pico projectors, and uploaded to their eportfolios from the point of capture using 3G connectivity enabled by mobile broadband hotspots allowing the students to connect in small teams of up to five members, sharing resources and connectivity. Students were required to regularly tweet their progress throughout these two days, allowing their lecturers to

provide formative feedback and guidance on their progress and ideas. The eCV COP then continued weekly throughout the rest of the semester, supporting the development of the student projects, and culminating in the student teams presenting their projects at the end of year Grad Show.

Architectural Education Affordances of the iPad
The unique affordances of the iPad utilized within the Architecture student eCV projects are summarized in Table 2.

iPad Capability	Supporting Social Constructivist Pedagogy	Example Application of Affordances
Image Editing and sharing	Student content generation and sharing situated learning contexts (Bruns, 2008; Stead & Colley, 2008).	Situated learner-generated content, including: geotagging of photos on smartphones, and direct upload to Web 2.0 sites for sharing. For example: Photoshop Express App
Video Editing and sharing	Learner-generated content and sharing of situated learning contexts (Bruns, 2008; Stead & Colley, 2008).	Situated user-generated content such as VODCasts, interviews, real-time streaming or asynchronous upload to Web 2.0 sites and Skype video calls. Capturing critical incidents in students' learning journeys. For example: http://www.youtube.com and Reeldirector App
Geolocation	Facilitating situated learning or authentic learning (Herrington & Herrington, 2007).	Group activities involving: Mapping, Geocaching, and Navigation. For example: http://maps.google.com
Augmented Reality (3G model)	Bridging learning contexts by supporting learner-generated contexts (Cook, 2010; Luckin, et al., 2010).	Using the built-in camera, GPS and compass to overlay the physical environment with student created POIs (points of interest) and location-based data. For example: http://www.layar.com and http://www.wikitude.com
Microblogging	Collaborative publishing and communication across contexts (Luckin, et al., 2010), such as geographic and time-zone barriers.	Asynchronous communication, collaboration & media sharing beyond the classroom. For example: Twitter http://www.twitter.com
Sketch Pad	Concept linking and sharing of learner-generated content (Bruns, 2008).	Student idea creation and sharing.

Table 7: iPad architecture pedagogical affordances.

Contemporary Music Diploma
The 2010 iPad mlearning project was the third iteration of mlearning within the Diploma of Contemporary Music course. The 2010 iPad project was preceded by a 2008 iPod Touch project and a 2009 iPhone 3G project. These preceding projects established the importance of the integration of the mlearning projects into the course assessment and delivery, and the establishment of a supporting community of practice (Cochrane, 2009; Cochrane, et al., 2009). In 2010, the use of the iPad was integrated into the second year music technology paper. The project was scaffolded by the formation of a weekly community of practice involving the researcher as the technology steward, the course lecturer, and the course students. The COP investigated the application of the iPad to the course and it's music creation and sharing capabilities. Within the course the iPad was used by students to complete three assignments: an online eportfolio project consisting of at least five blog postings outlining the progress on their work throughout the course containing and promoting student-generated content including audio (30%), an internet search assignment (20%), and three digital audio tasks using the iPad to record environmental sounds which were then mixed into coherent music tracks using Logic and ProTools (15%, 20% and 15%).

Students experimented with a wide range of affordances of the iPad throughout the project, including both productivity applications such as notes, email and blogging, and a variety of music playing, theory, composition and recording applications. The Music students were particularly engaged by the touch interface of the iPad which appealed to their kinesthetic nature as musicians. This is illustrated in a transcription of a student VODCast reflecting upon their experience.

I used it [the iPad] for my digital audio recording assignment and some compositions. Of course I also played games on the iPad! I used the application Audionote for the recording task, and Sonatanote and Virtuoso for compositions. I think it is a very handy tool for my tasks – it is portable, and easy to use because it has a touch pad. Through this course I have come to know digital technology better than before. Before this course I could only compress CDs into mp3 or ogg files, but now I can make my own digital music pieces… I think this course was very helpful for my music career. (Diploma of Contemporary Music Student, 2010)

Music Education Affordances of the iPad
Example affordances of the iPad utilized in the Contemporary Music Diploma mlearning project are outlined in Table 3.

iPad Capability	Supporting Social Constructivist Pedagogy	Example Application of Affordances
Music Creation and Performance	Student content generation and sharing within situated learning contexts (Bruns, 2008; Stead & Colley, 2008).	A wide range of music creation applications including: drum machines, DJ apps, virtual synthesis, virtual keyboards, sample editing, full music production: For example via Garageband for iPad
Musical Notation Reader	Collaborative performance	Following score sheets from the iPads during band practices and performances
Blogging	Critical reflection and peer commenting	Collaborative student ePortfolio creation
Video editing and sharing	Learner-generated content and sharing of situated learning contexts (Bruns, 2008; Stead & Colley, 2008).	Student VODCast editing (video recording will be a feature of the iPad2). For example ReelDirector and iMovie
Audio Recording and editing	Sharing of student-generated content in a variety of contexts	Recording and sharing of environmental sounds and student performances: For example Audioboo and Soundcloud
Web Connectivity	Collaborative communication and research	Student team-based research, online community building, eportfolio generation

Table 8: iPad music pedagogical affordances.

Civil Engineering
The second semester students from the Civil Engineering certificate course in 2010 participated in this project. The students enrolling in this course were required to buy a scientific calculator worth around $400NZ. This scientific calculator had a very limited use in class, mainly for calculations and programming use only. The course has a mix of theory and practical sessions including four field experiments. Students meet once in a week for a four-hour lecture that is followed by a three hour practical session, learning to use the surveying equipment to read data that is subsequently used in calculations. The student's recorded the field experiment data on a sheet of paper and this was later (when the students return to the classroom) checked by the lecturer. The limitations of this approach meant that the data couldn't be verified by the lecturer during the field experiments because the students worked in groups and would be located hundreds of meters away from the lecturer. This created a few problems for the students and the lecturer. The lecturer couldn't provide feedback nor verify the data collected by the students. This could only be done when the students were back in the classroom. Because the data was collected on paper it limited the calculations that could be performed by the students in the field. A survey of the students revealed that they found the four-hour lecture 'overwhelming' and 'boring'. The lecturers teaching the course reflecting on the four-hour sessions stated that standing in front of the class talking and going through PowerPoint presentations and pdf's was the norm for delivering the course content to the students. Learners in the class played a passive role in this learning process. The 'learning' and 'assessment' in the course were seen as two distinctively separate processes. Learning involved lecturer-mediated content. Assessment involved student knowledge recall.

The use of the iPad together with some free Apps available from the App store became a catalyst for a transformational shift in the classroom from a lecturer-centred pedagogy to student-centred social constructivism. Students downloaded the m48 scientific calculator for the iPad for free. Documents 2, another free App available on the iTunes Appstore, allowed the students to edit, create, download and synchronize documents from Google docs. Google Buzz was used for collaborative micro-blogging, while the use of Theodolite and mobile blogging addressed the issues of access to data beyond the classroom. Although the

project was initially promoted as a way to replace the course-required calculator, the affordances of the iPad created opportunities to engage the learners in the learning process, moving the embedded course pedagogy along the PAH continuum to Andragogy. Students' used the iPad to blog and Buzz to seek feedback from their peers, the lecturer, to share ideas and communicate. The field experiment data collected by the students were able to be verified by the teacher in context via Google docs providing the students with an opportunity to correct the mistakes by taking another reading.

Engineering Education Affordances of the iPad
Example affordances of the iPad utilized in the Certificate of Engineering mlearning project are outlined in Table 4.

iPad Capability	Supporting Social Constructivist Pedagogy	Example Application of Affordances
Scientific Calculator	Enabling sharing of data and calculations in context via wireless connectivity	Virtual emulation of the required scientific calculator
GPS for Geolocation (3G model)	Facilitating situated learning or authentic learning (Herrington & Herrington, 2007).	Group activities involving: Mapping, Geocaching, and Levelling. For example: http://maps.google.com, Theodolite.
Google Docs	Collaborative publishing and communication across contexts (Luckin, et al., 2010), such as geographic and time-zone barriers..	Situated user-generated content such as field data, reflections, sharing of useful resources and collaborative learning through enhanced communication and connectedness across learner generated contexts (formal and informal).
Microblogging	Bridging learning contexts by supporting learner-generated contexts and collaboration (Cook, 2010; Luckin, et al., 2010)	Asynchronous communication, collaboration & media sharing beyond the classroom. For example: http://www.twitter.com
Blogging	Learner-generated content and sharing of situated learning contexts (Bruns, 2008; Stead & Colley, 2008).	Student idea creation and sharing.

Table 9: iPad engineering pedagogical affordances.

DISCUSSION

The Bachelor of Business iPad project enabled a high level of student interaction and engagement within classes, allowing the course lecturer to move away from a lecture-based approach to a collaborative workshop approach to the classes. Students were also enabled with flexible access to course materials and communication tools beyond the classroom.

After an initial collaborative investigation of the affordances of smartphones and the iPads, the eCV Architecture mlearning student projects were brainstormed and negotiated by the students with the course lecturers. This approach represented a paradigm shift from pedagogy (teacher-directed) towards heutagogy within the course. The eCV mlearning project also enabled student-generated content and student-generated contexts beyond the face-to-face classroom with students geotagging images and video of Architecture throughout the city.

The Contemporary Music iPad project integrated the use of the iPad as an illustration of how music production and delivery is influenced and changed by the introduction of new technologies. The iPad project also allowed students to experience a more flexible learning environment than the courses dedicated music lab, and enabled the course lecturer to integrate student-generated content and authentic learning contexts into the course. The Contemporary Music iPad project thus enabled a pedagogical shift from the more lecturer-directed approach of the rest of the course to student-centred andragogy within the mlearning project.

The Civil Engineering iPad project enabled bridging of class field trips and the classroom-based lectures, creating an authentic bridge between the theory and practice of the course. However, the physical size and perceived fragility of the iPad were viewed as negatives for using the iPad during field-trips by the participating students. As a direct replacement for the course required scientific calculator within a smaller form-factor than the iPad the iPod Touch may well be a better choice for this context in the future.

Implications for 2011

The 2010 iPad projects generated huge interest from lecturers on the periphery of the communities of practice surrounding each project, providing the potential to drive pedagogical change throughout each of the departments. To achieve this communities of practice of lecturers in each department have been established investigating the potential of the integration of the ipad and mlearning within their own courses. Three of the departments have purchased iPads for lecturers to trial as members of these communities of practice. The Architecture eCV elective course has been refocused directly on creating mobile web 2.0 evangelists within the department in 2011 and the surrounding COP broadened to include international collaboration between students and lecturers in courses in the UK and Spain. Within the context of contemporary music course the iPad has developed from a mobile productivity tool and grown into a powerful music platform with over 2640 apps in the iTunes Store music category, most costing a fraction of their laptop or desktop computing versions. This presents a range of course integration opportunities for 2011. The Bachelor of Business programme is now investigating all first year students purchasing their own iPads for the second semester of 2011, and the Civil Engineering course requirement has changed from a dedicated calculator to include the option of an iPod Touch instead.

CONCLUSIONS

While initially designed and presented as a web enabled content delivery device the iPad iOS ecosystem has developed into a powerful collaboration and content generation platform. Leveraging the optimal pedagogical impact from these devices requires innovative pedagogical design and support. The four iPad mlearning projects outlined in this paper provide examples of the pedagogical integration of the iPad within social constructivist learning environments, supported by the reimagining of courses around communities of practice.

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Supportive Scaffolding MLearning Theory for Language Learning through Interaction

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ABSTRACT

The increasing widespread of mLearning application in educational institutions, museums, business organisations and other contexts calls for the need for a theory in defining the education practice across these contexts, and also because of the ability of theory in defining research agenda and producing predictions and generalizations. Relatively in language learning, interaction is the vital element in the individual's process of learning and acquisition of the language, and mlearning could assist in the language learning process uniquely if not naturally owing to the fact that mobile devices and technologies are fundamentally designed for communication. However, the question lies on how mlearning could actually aid in language learning. This paper proposed to describe using Vygotsky's Zone of Proximal Development, Scaffolding Theory and Krashen's Theory of Second Language Acquisition on how learners could be assisted in language learning via supportive scaffolding. The author also attempt to explain how scaffolding is applied in assisting the learners learn by proposing the MLearning Five-stage Scaffolding model which is adapted from Gilly Salmon's five-stage scaffolding model. As mlearning should include informal learning, the key characteristic of the model shows how formal learning and informal learning can be interwoven using mLearning.

Author Keywords

mLearning, language learning theory, scaffolding, supportive scaffolding, interaction

INTRODUCTION

Interaction has been regarded as essential component of the learning process (Tu & Hsiang, 2000), and level of interaction among learners affect the quality of their learning experiences (Navarro & Shoemaker, 2000; Scott Grant & Hui Huang, 2010; Vrasdisas & McIsaac, 1999). Interaction should promote learners to be active participants in the learning process where ideally learners involve in meaningful listening, speaking, reading, and writing activities as well as opportunities to reflect upon ideas, issues and concerns (Meyers & Jones, 1993, p.6). Learning through interactions also allows the shift from the traditional focus on teachers and learning materials to the students where they actively engage themselves in the learning process where knowledge is negotiated and acquired among their peers, instructors, materials and learning context. Past studies has revealed the impact of interaction to learning; for example, higher levels of interaction are linked to improvement in students' learning achievement (Gokhale, 1995; Kekkonen-Moneta & Moneta, 2002), encourage positive students' learning attitudes (Althaus, 1997; Fulford & Zhang, 1993), and improved students' critical thinking skills (Yang et. al., 2008). Since interaction is an established criterion in effective learning, mLearning could further facilitate learning as mobile technologies could enhance interactions among students and instructors. The pervasiveness of mobile technologies and devices such as mobile phones, PDAs, smartphones, and the new revolutionary IPADs also supports synchronous and asynchronous communication that leads to collaborative learning among students and instructors. Furthermore, the variety channels of communication that students can choose from such as SMS, MMS, voice calls, podcasts, blogs and many more could overcome cultural and communications barriers among students, instructors and the institutions. This further enhances meaningful interaction that is essential for meaningful learning. The media rich environment offered through mobile technologies that can be accessed by students at anytime, anywhere and just-in-time support different students' learning needs that enables personalised learning, thus enhance student-centred learning. In language learning, one of the methods via interactions to improve students' language competence is through peer feedback where students' written work or oral presentations are responded by their peers (Zeng, 2006). In writing activity, peer feedback means having other writer to read and to give feedback on what other writer has written (Hyland, 2005); or in speaking activity,

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it means other students give feedback on quality of oral presentations of other students. In short, peer feedback allows students making negotiation of their strength and weakness (Williams, 1957; Spear, 1988; Hyland, 2005) where the students can negotiate ideas, comments, corrections, and suggestions (Zeng, 2006; Kamimura, 2006; Jiao, 2007), allowing students having opportunities to be better in writing, and also reading. However, it is not to be misunderstood that peer feedback is the only way to aid students; any other activities based on interactions could also benefit students of higher proficiency level to acquire higher language or communicative skills. The notion where knowledge is best negotiated and acquired through interaction with each other as illustrated above, aligned with the beliefs of Social Constructionists (Kurt& Atay, 2007). One of the theories in the past supporting this method of learning is Vygotsky's theory of Zone of Proximal Development (ZPD). ZPD is one of the three major themes in Vygotsky's Social Development Theory (1978). According to Social Development Theory, Vygotsky envisages that social interaction precedes development where consciousness and cognition are the end product of socialization and social behaviour.

Vygotsky's theory of Zone of Proximal Development (ZPD)
Vygostky defines the ZPD as "The distance between the actual developmental level as determined by individual problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygostky, 1978:86). In other words, referring to Figure 1, ZPD is the distance between the most difficult task someone can do alone and the most difficult task someone can do with help (Vygotsky in Mooney, 2000:83).
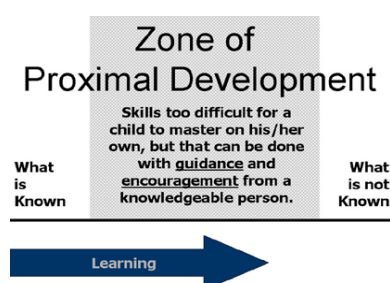
Figure 1. Zone of Proximal Development

In his theory, Vygotsky stresses that an interaction is vital for a learner in the edge of learning where the learner can benefit from the interaction to enhance his or her learning achievement (ibid). He stresses that interaction between the learner and other more skilful peers could effectively aid in developing the learner's skills and strategies. In the context of this study, lecturers may include cooperative language activities where skilful peers could help less competent language learners within the learners' zone of proximal development. Now, these more skilful peers are what Vygotsky terms as the More Knowledgeable Other (MKO). MKO is an important concept that relates to the difference between what a student can achieve on his own and what the student can achieve with the guidance and encouragement from a more skilled partner. This concept implies that not necessarily higher interlocutors such as lecturers or instructors but other students too qualify to be the MKO. The assistance given by the more skilled learners here is what is also termed as 'scaffolding'. However, Vygotsky never used the term scaffolding in his theory, but the term was first introduced by Wood, Bruner, and Ross (1976, cited in Tharp & Gallimor, 1988) as a metaphor to idealize the role of a teacher. Vygotsky suggests that when a student is at the ZPD, he should receive the appropriate assistance (scaffolding) by an MKO just enough to achieve the task. Once this student gain mastery of the task, the 'scaffolding' may be removed and he would be able to face the task on his own again. This is likened to scaffolding as a metaphor taken from building construction where the scaffolds are use to support workers to construct a building and the scaffolds will be removed once the building is completed (Johnson, Christie, & Wardle, 2005). However, in education, this metaphor is argued as more suitable for a "well-defined end" and is teacher-centred (Duffy and Cunningham, 1996, p.183). This type of scaffolding is known as 'Directive' scaffolding where students are expected to acquire standard skills and knowledge taught through series of specified content and strategies designed by an instructor. However, in practice, scaffolding should be a learner-centred strategy where learning ends are determined by the learners' needs. This type of scaffolding, better known as 'Supportive' scaffolding which manifests in instructions tailored to students needs based on their own ability and interest (Lenski and Nierstheimer, 2002). In scaffolding, the ZPD actually serves as a critical concept. ZPD concept was originally applied in face-to-face tutoring but later it was found to be also successful in other settings where computer software could serve as scaffolding support. For examples, a software design framework, the Learner Centred Design(LCD) was developed based on scaffolding as main support for learners (Soloway, Jackson, Klein, Quintana, Reed, Spitulnik, Stratford, Studer, Eng, & Scala, 1996; Wood, Bruner, & Ross, 1976) and the ECOLAB (Luckin, 1999), a tutoring system developed based on the Vygotskian design framework which provides interactive environments to assist children aged 10-11 years to learn about

food chains and webs. ECOLAB is found effective in assisting the children through providing appropriate challenging activities. The learner model is also able to track the learners' individual capability and potential in order to provide right amount of collaborative assistance during the activities. In this way, ECOLAB not only assist learners in reaching beyond what they could not achieve alone through the activities but also explicitly direct them through the activities with success. Other examples like QUADRARIC (H.Wood & D. Wood, 1999) offers assistance when needed by the learners where a tutor would continually monitor their activities logged into the system in order to response when help is needed and also to determine the type of help whereas DATA (H.Wood, Wood, & Marson, 1998) would offer online assessments to learners and offer tutoring to them based on evidences of errors made. All these tutoring system capitalize on scaffolding the learners to reach their projected learning outcomes where assistance are offered based on the learners' individual needs, level and pace within their ZPDs.

In all the examples given above, the MKO plays a significant role in providing the scaffolding for the learners to deal with their ZPD and the MKOs are usually a more capable peer, a tutor, or a lecturer. However the MKO may not necessarily be in human form as presented by John Cook's (2010) augmented contexts for development mediated by mobile phones which actually reconceptualize Vygotsky's notion of ZPD. He argues that the context of learning for the century is augmented and accelerated by mobile devices and technologies through new digital tools and media. This actually supports augmentation as a fundamental way in conceptualizing mlearning (Quinn, 2011; Metcalf, 2006 in Quinn, 2011). Bruner (1985), through his introduction of Scaffolding theory which is most associated to development of language skills, describes the development of young children's oral language acquisition through instructional support and process mediated by the adults in learning through the joint construction of language and gradually withdrawing their support as children gain independent mastery of the language. The key element here is learning through interaction between the adult and the child in assisting the child to develop something beyond his or her independent efforts. The assistance (scaffolding) will be gradually removed as the child gain independence in their learning (Malcolm, 2010). This provides their view on the purpose of education by saying that it is to assist the learners to achieve the level of development that they would not be able to achieve on their own. However, Greenfield (1984, cited in Tharp & Gallimor, 1988) exerts that scaffolding should not be misunderstood as simplifying the task faced by the learners or given to them, but rather simplifying the learners' role in solving the task through gradual assistance from their instructor or more skilled peers.

Vygotsky's theory of education as a fundamental human activity (Moll,1990) involves people with roles as instructors and as learners where communication process exists between them in order to assist the learners to solve learning problems that they are not able to do so by themselves. In fact, problem solving in Vygotskian's perspective is cultural based (Rogoff, 1990) as she states: 'Interactions in the zone of proximal development are the crucible of development and of culture'. This means that education is not merely interaction between teachers and learners but also interaction between problems and knowledge in a culture of how to deal with the problems. In short, as Vygotsky's Theory of ZPD postulates learning on social interactions in facilitating learners' learning and cognitive development, the theory supports mLearning as mLearning also thrives on interaction and communication among individuals for learning too. Interestingly, if taken in the opposite perspective, mLearning could in turn support this learning theory. For example, one of the criticisms of ZPD is that it is impossible for a teacher or an instructor to attend to all his students' ZPD in the classroom due to factors like time constraint and large class size. To add to the odds, different students would have different ZPD and time taken to attend to each of the ZPD depends on the students as each of them would have different learning pace. However through mLearning, via mobile technologies and devices, there is a larger repertoire of communication channels which the students could resort to seek help from more 'experts'(MKO) other than their teachers or instructors to interact with in order to meet their learning needs at their own pace in or beyond classroom walls detached from time constraint.

Krashen's Theory of Second Language Acquisition
Relation to the notion of scaffolding, another language theory that the authors adopted to describe undergraduate language learning is Krashen's (1987) Theory of second language acquisition. In order to illustrate the relevancy of Krashen's theory to scaffolding, it is necessary to present a brief outline of the principles which form the theory. The theory consists of five main hypotheses which are related to each other: 1) the Acquisition-Learning hypothesis, 2) the Monitor hypothesis, 3) the Natural Order hypothesis, 4) the Input hypothesis, and 5) and the Affective Filter hypothesis. The notion of scaffolding can be observed in Krashen's Input hypothesis where he devised a similar notion for the kind of input that a second language student needs in order to make progress in acquiring the target language as illustrated in the formula 'i+1'. Referring to Figure 2, box B represents the learner's previous competency of the targeted language which brings about the learner's present level of competency **'i'**(shown by Box A in Figure 2). In the context of this paper, the '**i**' could represent the undergraduate learner's present level in speech or writing competency of the English Language. However, the learner for instance may have problems in using the appropriate formal language in writing a technical report or participating as one of the speaker in a business meeting. In order for the learner to meet this needs or develop

the desirable competency of Box C in Figure 2 (for example be able to use formal language structures in writing and speaking), the learner needs an input where Krashen insists in a slight input 'i+1' as a sufficient condition to acquire the desirable level. This is to ascertain the input is made comprehensible, fundamentally suggested by the Input hypothesis. To explain in a different light, learners for example would have problem in coping with the language if the input is 'i+ 18' as they would not be able to understand the input, thus impedes acquisition. The 'i+1' here in relation to scaffolding theory represents the learners' ZPD. Through learner's interaction and communicating with their MKOs (instructors or peers), the input i+1 could be obtained to help the learner solve his ZPD to reach the desirable level. Of course the input 'i+1' should not be misunderstood as merely a single input added to previous input to achieve success. The 'i+1' necessarily means a process of comprehensible input which takes time for the learner to achieve the desired result. As for example given earlier in this section, the learner may initially know the mechanics of writing a report or criteria of being a persuasive speaker (Box B in Figure 2) but is not able to perform effectively as he is having problem with appropriate formal language to do so (the learner's ZPD). With the help of the MKOs, through a process of comprehensible language input shared (i+1), the learner would be able to solve his ZPD to be able to write and speak in formal situations (Box C in Figure 2). The comprehensible input here serves as a 'scaffolding' to help the learner acquire the desirable level.
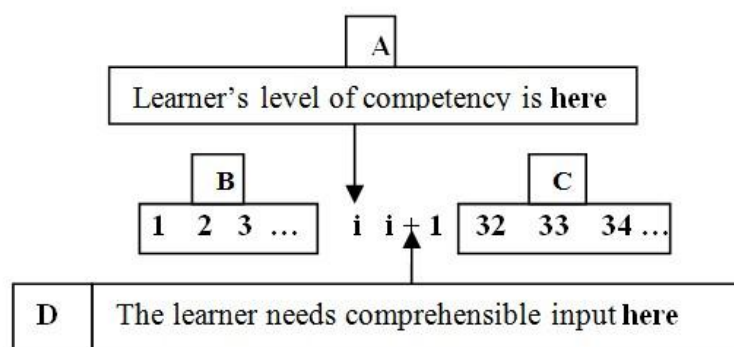
Figure 2. Krashen's Input Theory

Based on the discussion above, the three theories presented here serves as a theoretical framework for mLearning in this discussion where the theories complements each other.

MLearning five-stage scaffolding model

To illustrate further how scaffolding could assist language learners learn in mLearning, the study proposed the adaptation of Gilly Salmon's five-stage scaffolding model (Salmon, 2000). This model as shown in Figure 3 was designed to promote interaction among students with the particular aim to increase student participation in computer-mediated conferencing in order to promote joint knowledge construction and increase learning (Olsen & Monty, 2006). The model was originally developed for eLearning in support of social learning theory which capitalized on meaningful interaction based on Salmon's key premise that the learners' ability to learn online goes beyond the boundaries of technical aspects, encompasses an underpinning social learning principles, where every individual surrounding the learner plays an important role in the learners' learning through their relationship with them under the support and guidance of a moderator. This is in line with the theory of mLearning which saddles on interaction as means of learning. Similar to Salmon's key premise, mLearning concept should not be technocentric or conceptualized in terms of technology or mobile devices rather learning should be perceived as a result of interactions among learners, teachers, mobile devices, knowledge, and the learning context. Salmon's model could also be seen as an extension of Vygotsky's Zone of Proximal Development (Attwell, 2006) accordingly to the model's structure where the moderator gradually shift the responsibility of learners' development to the learning community guidance while the learner eventually takes charge on his learning by developing own scaffolding through relationship with other members of the community an also beyond the community.
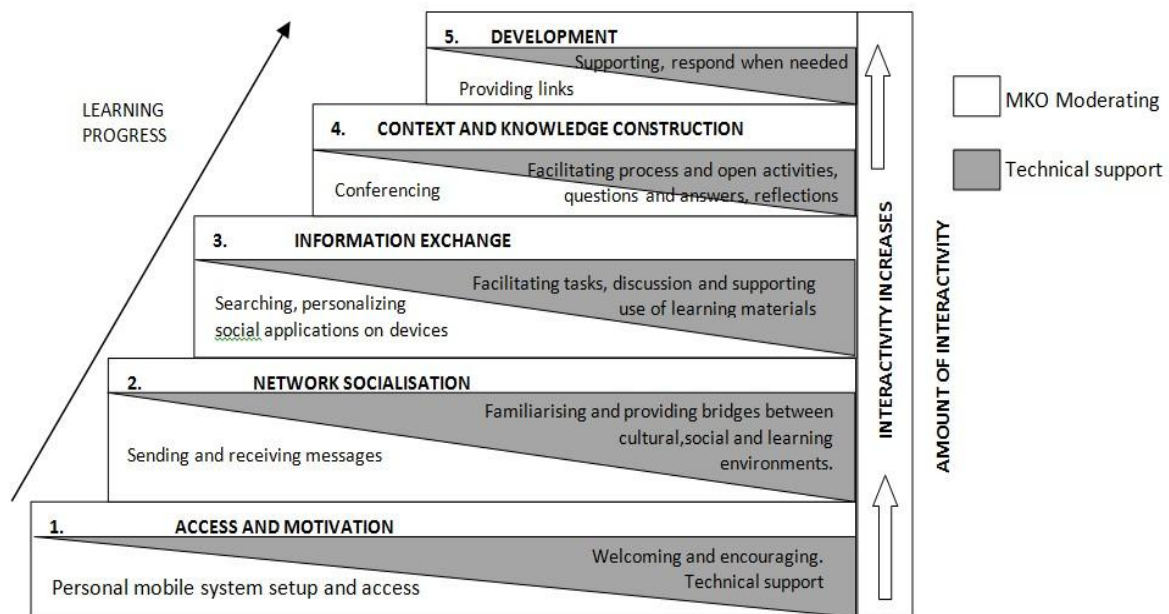
Figure 3. MLearning five-stage scaffolding model

This model consists of 5 stages:

Stage 1 : This stage aims to promote individual learners' access and participation in social conference by welcoming them and providing technical support to facilitate use of mobile technology and devices in learning. Technical support could be shared with instructors, system providers as well as from other learners. Students move on to Stage 2 once they post their first messages.

 Stage 2: This stage involves the students to establish their network identities and choose their social groups to interact by signing up as members or participants of a virtual community or even collaboratively creating own social groups relating to mutual learning needs with other individuals.   Learning needs could be broad themes like socializing and writing or on specific needs like effective technical oral presentation or writing engineering research report. The term Network Socialisation replaced Salmon's Online Socialisation due to two premises:

1) Online is usually associated to connectivity to computer technology and communications which specially refers to states or conditions of device or equipments or other electronic functional units (Federal Standard 1037C, 1996). This implies that online socialization relies on connectivity of computers and devices which is an essential factor for e-learning; thus an 'offline state' would compromise the learning process.
2) Network refers to a system of connectivity not only of technology devices, systems and applications but also of people. In the adoption of Salmon's model, network implies a shift of focus on technology to the act of individuals forming and generating communication networks among themselves to interact mediated by technology devices and applications. MLearning should place a primary focus on on the learners, their mobility and interactions rather focusing on technology; hence learner-centred learning. In the learning process, the learning environment and interaction among the learners should be the main foreground of the learners whereas the technology devices should be the background. In other words, the learning process continues with or without the connectivity of technology devices (online). The use of the term 'Online' would be more suitable for the unstable technocentric definition of mLearning.

Stage 3:   Stage 3 involves initial scaffoldings to facilitate students' development in their language competencies where they begin to interact and cooperate with each other by exchanging learning experiences to support each individual's goals. The focus of learning here should be on creating sustainable networks of human interaction to facilitate learning needs where the technology devices qualify only as medium. Information exchanges could be initiated to and fro among social softwares such as moblogs or podcasts, instant messages through Short Messages System (SMS) or Multimedia Messaging System (MMS), and voice calls on mobile devices, and face-to-face classroom interaction.

Stage 4: This is the stage where interactions among students becoming more collaborative where students act on information shared in Stage 3 to form specific group discussions on mutual subjects. Students not only embark on knowledge constructions but they would also generate learning context on site that would also lead to more knowledge construction; the students may share common learning environment or context and develop the digital representation of the site or context using mobile technology. The site or context may not necessarily be a physical environment where the students is placed but could also be a network space or even a conceptual or abstract place such as a mutual learning subject or a learning problem (Nonaka, 1966). Laurillard (2007) terms this act of learning through generating context as 'digitally-facilitated site-specific learning' which is an intrinsic nature of mobile technologies which is not shared by other distance learning technologies such as desktop and landlines. This type of learning is very motivating as it offers learners a high degree of ownership and control. Through digitally-facilitated site-specific, the learners could share common grounding instantaneously through digital representation of the learning environment or sites through video clips or pictures delivered to their mobile devices via MMS, podcasts, moblogs or bluetooth technology. This will consequently lead to meaningful interactions among learners to better achieve learning goals.

Stage 5: This final stage is where the students reflect on what they have learned or acquired to help them achieve their learning goals. The reflection would lead to students' critical thinking to develop better or newer skills in developing higher competencies. For example, by reflecting on their learning process in Stage 4, learners would be able to understand better the elements to become better speakers and ways to utilise the new acquired skills to achieve their goals. This would also lead to new learning goals to develop further from their new acquired competency level.

Based on this model (Fig.5), learners are expected to master the required different technical skills in each stage that involves different moderating for each stages as described above. The running bar 'interactive bar' indicates the increasing amount and the frequency of interactions among learners, content and context as the learners progress from one stage to another. For instance at Stage 1, the student may interact with one or two students through a couple of electronic messages and gradually increase to more students more frequently with more messages and types of messages throughout the five stages which also constitutes his learning process. Usually at Stage 5, the acquisition of new level of knowledge and competency will lead to new learning pursuit of the learner. The theories and the model above are adopted in describing how undergraduate language learners learn through peer interactions at tertiary level in the context of mLearning in undergraduate language learning.

CONCLUSIONS

Theorizing mLearning should be based on the instructional problem or goals and then select the most appropriate theory options to help address the problem or goals of instructions. This paper adopted Vygostsky's Zone of Proximal Theory to view how students generally learn via mLearning, and to support further specifically on how students acquire language, the study adopts two language learning theories: Scaffolding theory and Krashen's Theory of second language. Gilly Salmon's five stage model is adapted and proposed to describe how learners learn language via mLearning based on the proposed theories. It was the author's aim to leverage on these learning theories to lend a perspective on how students' learning needs could be fulfilled using mobile devices and technologies to fulfill learning goals. The aim not only attempt to prove that past learning theories are still relevant in describing the learning of today especially to some educators who are more familiar and confident with long established learning theories.

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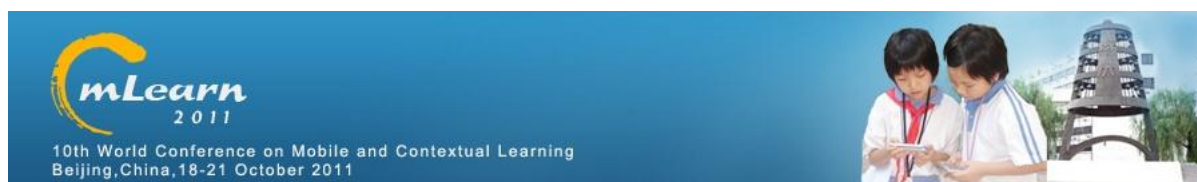
mLearning Literacy

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ABSTRACT

Much has been written about mobile learning and various theoretical frameworks have been developed to underpin the studies that have been reported.   A fundamental question that this paper asks is *where does digital literacy fit in with the learning that uses mobile devices*? This conceptual paper will explore several questions about mlearning literacy - the digital literacy associated with learning with mobile devices. It will argue that fundamental to learning with mobile devices is the need to develop the associated digital literacy in students. While much of the literacies will be common across the use of technology in general, there are other skills and knowledge associated with learning with mobile devices that need to be emphasized, both in the formal and informal contexts. These include technical and conceptual skills such as the differences between devices, the affordances and limitations offered by mobile applications and the multimodality of representing concepts in mobile devices.   The paper advocates that being mlearning literate would empower students to learn better and safer with mobile devices and their applications.

INTRODUCTION

Much has been written about mobile learning and various theoretical frameworks have been developed to underpin the studies that have been reported. But little about digital literacy has been written or incorporated into the frameworks. A fundamental question that this paper asks is *where does literacy fit in with the learning that uses mobile devices*? The literacy in this context is mlearning literacy. As with literacy in other areas, being literate with mlearning means not only possessing functional skills and knowledge to carry out the learning but also conceptual understanding of the wider implications of the learning. The paper will explore several questions about mlearning literacy - the digital literacy associated with learning with mobile devices. It will argue that fundamental to learning with mobile devices is the need to develop the associated digital literacy in students.

In this paper, mlearning is defined as learning with mobile devices and includes learning in both formal and informal situations. 'Learning with mobile devices' is distinguishable from 'mobile learning'. The former emphasises the
ubiquity of learning where the suite of available technologies needs to interact and support the learning with mobile devices. In this respect, the learning could be both formal (located in or oriented to classrooms) or informal (flexible in location and time as well as not constrained by institutional purposes). The term "mobile learning" is frequently associated with single devices or the use of only one device at a time, usually informally and/or on the move, for example,   learning chemistry in the train (Hedin & Norén, 2009), listening to podcasts anywhere anytime (Evans, 2008; Goodchild & Chenery-Morris, 2011) or undertaking a field assignment (Shih, Chuang & Hwang, 2011). Discussions of "mobile learning" often fail to consider the complementary affordances of different technologies e.g. the connectivity required for Bluetooth between a handheld device and a desktop computer in order to print. The ubiquity of learning that takes into account informal learning with mobile devices forms part of the mlearning literacy of this paper.

The questions that this paper attempt to address are:
1. What is mlearning literacy and how is it different from literacy that is desktop computer- or laptop-based learning?

2. Why should educators embracing programs of learning with mobile devices pay more attention to mlearning literacy?

3. What are the implications for teachers?

MOBILE DEVICES AS SOCIAL AND PEDAGOGICAL TOOLS

Mobile technologies are one of the fastest growing areas of technology. Mobile phones, iPhones and phones with android operating systems are on the rise (Whitney, 2009). An online BBC (2008) report indicated Neilson's finding of a 25% increase in mobile Internet usage compared to just 3% increase in desktop access for 2008 (2nd and 3rd quarter of the year). It also found that the mobile net users were younger and searched for different things on the Internet. The increase is attributed to the cheaper mobile phone rates, improved network technology and more user-friendly mobile phones. Tablets are also on the rise. As reported[6] by CNET Tech Review, the year 2010 saw the tablet wars heating up between new tablets from Acer, the Samsung Galaxy Tab and Apple's iPad[7] 1. In the context of this paper, mobile devices are those that are easily portable by learners of all ages and with easy access to the Internet. In consequence, they are handheld and constrained in their processing capacity. The definition includes mobile phones, smartphones, personal digital assistants (PDAs), iPods, MP3 players and tablets (including iPads and the array of recently released Android-based tabs) but excludes laptops and notebooks. The paper makes a case that while there are similarities in the digital literacies between these mobile devices and laptops/desktops, the constraints and ease in portability of the mobile devices present differences between them.

Mobile devices as social tools as well as social tools for learning

A significant part of Web 2.0 is its social web with online tools that allow people to (i) network socially e.g. through Facebook, Ning, Skype and other similar social network sites (ii) read, write and edit to collaborate e.g. building knowledge through wikis and cMaps and (iii) sharing ideas, opinions and knowledge e.g. through blogs, podcasts and videos on YouTube. The increased capacity to network with more learners and experts via Web 2.0 together with the 'always on' capability of mobile devices means that learners are able to access more resources to enhance their learning more frequently.
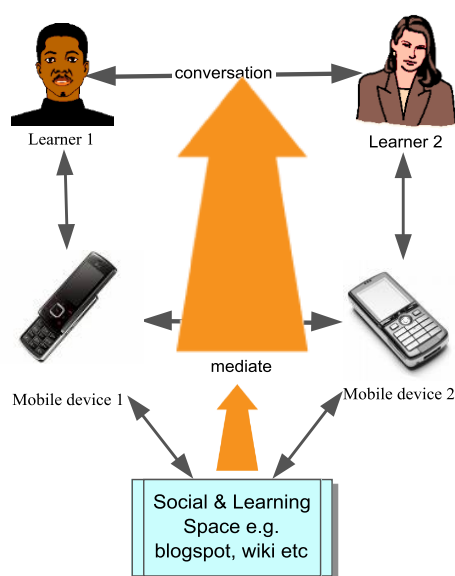
Figure 1. Mobile technology mediated socialization and social learning

Learning where the social context plays a crucial role in knowledge construction has been advocated by Vygotsky (1978). Vygotsky's socio-constructivist learning theory posits that the learning process centrally involves interaction with other individuals where culture and society will influence the learning. In a mobile social networked learning environment, a similar, relevant learning theory is the 'conversational theory' (Pask, 1976; Sharples, Taylor & Vavoula, 2007) that focuses on the communicative interactions between technology and people for the exchange of knowledge. The theory views learning as conversational processes taking place across multiple contexts (technology with technology; technology with person; person with person) within systems where people and technology are in 'continual flux'. Figure 1 shows the different levels of interactions/conversations in a mobile networked social and learning environment where mobile devices mediate the conversations between learners. Conversations include both audio/verbal and/or text-based messages/dialogues. Due to the size and limited capacity of mobile handsets, information needs to be chunked and 'dialogues' between learners via their mobile devices would need to be succinct and focused when externalising the learner's thinking - fostering the development of critical thinking and metacognitive skills. As most of the socialising and/or learning with mobile devices in networked social sites takes place informally, some formal teaching of the learners to be mlearn literate would assist them to learn better and safer when using mobile devices as social and social learning tools. The skills and

knowledge in being mlearn literate would include possessing critical thinking and soft skills (e.g. communicative skills, interpersonal skills) for interacting with online communities, such as when negotiating with a stranger (purchaser or seller) about a product on eBay using a mobile phone or text messages. These mlearning literacy skills are also life skills associated with a person's day-to-day living.

Mobile devices as pedagogical tools

There are numerous studies that report on the use of mobile devices as pedagogical tools. A mobile device that supports seamless learning will need to have information storage and retrieval capabilities, access to the Internet via wireless and/or 3G network, have applications that support learning and is easily carried around. Keegan

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[6] http://cnettv.cnet.com/tablet-war-heats-up/9742-1_53-50096867.html
[7] iPad 2 with added functions e.g. dual cameras, was released on 25 March 2011

(2005) asserts that small size, easily portable, user friendly, affordable and personal ownership are all important characteristics of a mobile device to support mobile learning. How mobile devices are used pedagogically is dependent on the functionalities of the different mobile device. Cheung & Hew's (2009) literature on the use of mobile devices in education identified seven ways in which they are used - as tools for communicating, capturing, analysing, assessing, task managing, accessing multimedia and representing meanings. The features supporting these pedagogical affordances are summarized in Table 1.

Table 1. Features of mobile devices that support pedagogy.

Mobile device	Features supporting pedagogy
Personal digital assistants (PDA); tablets	Computing capabilities: Word and Excel processing, PowerPoint editing and display; Internet access via WiFi; send files via infrared or Bluetooth; audio and video record; capture images; display multimedia using Flash[8] or other media players; operate educational application software and games that supports learning; geospatial positioning for navigation; task management software for organization and managing time/tasks
Mobile or cell phones	Communication devices – capabilities for voice or text messages with the more powerful ones able to access the Internet. Other computing capabilities – send files via Bluetooth; audio and video record; capture images; display multimedia using Flash and other media players; operate educational apps and games that support learning; geospatial positioning for navigation; task management software for organization and managing time/tasks
Smart phones (hybrids between PDAs and mobile phones)	Combined capabilities of both
Digital media players (iPods and MP3/MP4 players)	Access the Internet; cameras (in 4G iPod Touch) for image capture; audio record; display multimedia using media players; operate educational apps and games

The pace of adoption and research into the educational pedagogy of mobile technologies, while still considered to be in its infancy (Liaw, Hatala & Huang, 2010) has picked up dramatically in the last five years. A literature search in November 2010 (author, unpublished data), using LibExplore to search Education databases AEI (Informit), ERIC (CSA) and Linguistics/Language (CSA) with the key words 'learning with mobile technology' yielded 287 publications relevant to learning with mobile technologies dating from 2000 – 2010. Eighty-eight percent of these publications were in the 5 years from 2006-2010. The literature showed that the publications around the pedagogical uses of mobile devices are largely centred around PDAs (e.g. Fluck, 2008; Ng & Nicholas, 2009; Shih, Chuang & Hwang, 2011; Zurita, G. and M. Nussbaum, 2004), mobile/smart phones (e.g. Chng, Wati Abas, Goolamally, Yusoff & Singh, 2011; Grant, Daanen & Rudd, 2007; Hartnell-Young & Heym, 2008; Keogh, 2011; Stewart & Hedberg, 2011), and iPod/MP3 players (e.g. Belanger, 2007; Caron, Caronia & Gagné, 2011; Crispin & Pymm, 2009; Murray, 2011). The studies were mainly reports on the use of mobile devices in formal settings, mostly at the school level, and structured informal learning that is associated with tertiary level learning. What is less captured in the literature is the non-structured, often non-conscious informal learning that occurs with mobile devices in learner's everyday lives.

The pedagogical affordances offered by mobile devices mean that content can be delivered via multimodal representations – written, verbal, visual, embodied and in 3-dimensions, catering to the different learning needs of students and enabling them to learn better (Ng, 2010).

WHAT IS MLEARNING LITERACY AND HOW IS IT DIFFERENT FROM DESKTOP COMPUTER/LAPTOP-BASED LEARNING LITERACY?
mLearning literacy is digital literacy associated with mobile devices and their use for learning. Learning in this context is about subject matter (content) as well as life skills that are related to using and learning with mobile devices. These life skills include critical thinking, social, communicative and safety skills as well as skills that enable an individual to be resilient, for example in handling unwelcomed sms/email messages that are communicated via mobile devices.

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[8] Some tablets such as iPads do not support Flash software

The numerous definitions for digital literacy in the literature have been reviewed by Aviram and Eshet-Alkalai (2006) and Eshet-Alkalai (2004). They stated that the broadness of the definitions covers, singly or in combination, meanings that are technical, cognitive, psychological and/or sociological. Eshet-Alkalai (2004) suggested that there are five types of literacies that are incorporated within the term 'digital literacy': (i) photo-visual literacy; (ii) reproduction literacy; (iii) information literacy; (iv) branching literacy and (v) socio-emotional literacy. It is beyond the scope of this paper to discuss each of these literacies within the mlearning literacy context. Hence, the definition for digital literacy, that the mlearning literacy discussion for this paper will adopt, is that stated by the *European Information* Society:

- Digital Literacy is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process.   Martin (2005, p. 135)

Many of the digital literacy skills that are related to computer/laptop-based learning are transferable to mlearning literacy. Generic skills that apply to both computer/latptop and mlearning literacies include knowing about the machine that the learner is using, developing proficient technical skills so that they become automatised, selecting the right tool to represent the learner's thinking and understanding, critically analyzing data received (both information and conversational data) and constructing new knowledge in the learner's mind. The mobile user however needs to be able to differentiate between the different devices and how they differ technically and functionally as well as understanding the affordances and limitations of similar software in mobile devices. Table 2 lists the literacies related to computer/laptop learning and mLearning and shows the similarities and differences in the three categories (i) technical: technical and functional skills (ii) cognitive: critical thinking and evaluative skills and (iii) social-emotional: online social and safety skills.

Table 2. A comparison between mlearning literacy and computer/laptop-learning literacy. Adapted from Stephanie Rieger's (2006) and Ng (2010).

Skills & knowledge	Literacy	Computer/Laptop learning literacy	mLearning literacy
TECHNICAL: TECHNICAL AND FUNCTIONAL SKILLS	Able to use input and peripheral devices	for example mouse, QWERTY keyboard, earphones/headset, VGA connector, printer, USB drive, external speakers, smartboard	such as touch screen keypads, navipad, stylus, half-QWERTY keyboard, earphones, Bluetooth headset, USB connector
	Knowledge of working parts	in particular the common ones in 'Control Panel' for example: wireless, sound, display; use of multiple windows for multitasking	for example, infra-red, Bluetooth, wireless, memory card, data synchronization, use 'Settings' to control features such as sound, brightness; use of multiple windows. General understanding of standard device keys and controls such as soft-keys/navipad, how they differ for various devices and ability to successfully locate the equivalent keys on new devices to make calls or send SMS
	Able to troubleshoot by	reading manuals, accessing local Help functions and/or web-based resources (e.g. YouTube) for assistance	reading manuals, accessing local Help functions and/or web-based resources (e.g. YouTube) for assistance
	Able to operate adequately:	- understanding file structures e.g. folders and directories and managing where files are located in your drives - managing data transfer that includes understanding file sizes e.g. audio/video files often in MB and space to hold files; finding, downloading and installing applications (and uninstall when not needed), update /change user account information on the Internet; understand data charge costs associated with downloading data; creating shortcuts, embedding links, sending and retrieving	- understanding file structures e.g. folders and directories and managing where files are located in your drive/memory card and how to access your drive via your computer (understanding about operating system compatibility) - managing data transfer that includes understanding file sizes e.g. audio/video files often in MB and space to hold files; finding, downloading and installing applications (and uninstall), update /change user account information on the device and on the Internet; understand data

		attachments via email and/or Dropbox, opening them with appropriate applications, unzipping folder; creating a CD; for computers/laptops with infra-red and Bluetooth, use them for file transfer; cut, copy, paste, save and knowing where to find them - knowing about and able to locate frequently used user interface elements i.e. cues that define interactivity e.g. menu, sizing, dragging, scrolling, using sliders, collapsible lists; understanding tabs and their relationship to content; use of multiple windows for multitasking - set up and use communication/social networking tools e.g. emails, web mail, VOIP (e.g. Skype), Blogs, Wikis, Facebook etc	charge costs associated with downloading data; sending and retrieving attachments, opening them with appropriate applications, unzipping (e.g. using Pocket RAR), use infra-red and Bluetooth for file transfer; understand limitations of word processing, spreadsheet and presentation tools and compatibilities of operating systems and transferability of files between systems - knowing about and able to locate available user interface elements i.e. cues that define interactivity e.g. menu, sizing, scrolling, using sliders, understanding tabs and their relationship to content; use of multiple windows for multitasking - set up and use communication tools e,g. emails, web mail, VOIP, Blogs, Wikis, Facebook, Twitter, send SMS, MMS
COGNITIVE: CRITICAL THINKING & EVALUATIVE SKILLS	Use the Internet effectively for information gathering by	- being able to search, locate and assess Web-based information i.e. use appropriate browser and search engine, critique information through analysing and evaluating the digital content for accuracy, currency, reliability and level of difficulty - understanding that people behind the scene writing the information have their own motivations and critically evaluating whose voice is heard and whose is not is important for learning as neutrally as possible - knowing about the ethical and moral issues associated with writing that uses Web-based resources, for example copyrights and plagiarism - synthesising new understandings using appropriate online (e.g. wiki) or offline (e.g. Word, PowerPoint) tools that will convey the meanings in the best manner - understand the terms and conditions well so that legal liability is avoided, ensuring safety when meeting the purchaser or seller either online or offline to exchange goods and payment e.g. eBay	- being able to search, locate and assess Web-based information i.e. use appropriate browser and search engine, critique information through analysing and evaluating the digital content for accuracy, currency, reliability and level of difficulty. - understanding that most websites are not mobile friendly i.e. created for mobile devices and a fair amount of scrolling (up and down, left and right) will be needed to read information on the web - understanding that mobile web pages could contain reduced versions of non-mobile web pages and that the balanced perspective of the article may not be complete - understanding that people behind the scene writing the information have their own motivations and critically evaluating whose voice is heard and whose is not is important for learning as neutrally as possible - knowing about the ethical and moral issues associated with writing that uses Web-based resources, for example copyrights and plagiarism - synthesising new understandings using appropriate online (e.g. wiki) or offline (e.g. Word, PowerPoint) tools that will convey the meanings in the best manner and understand that the capacity of productivity application are reduced in mobile devices - understand the terms and conditions well so that legal liability is avoided, ensuring safety when meeting the purchaser or seller either online or via mobile phone to exchange goods and payment e.g. eBay

SOCIAL-EMOTIONAL: ONLINE SOCIAL SKILLS & SAFETY	Use the Internet responsibly for communicating, socializing and learning by	- observing 'netiquette' by applying the similar rules as in face-to-face communication such as respect and using appropriate language and words to avoid misinterpretation and misunderstanding - protecting own's safety and privacy by keeping personal information as private as possible and not disclosing any more personal information than is necessary - recognising when (s)he is being threatened and know how to deal with it, for example whether to ignore, report or respond to the threat - ensuring that anti-virus software is regularly updated to avoid spam and viruses.	- observing 'netiquette' by applying the similar rules as in face-to-face communication such as respect and using appropriate SMS language to avoid misinterpretation and misunderstanding - being aware that SMS language can impact formal language usage in classroom situations - balancing the amount of time spent on social networking sites and the amount of text messages sent in managing costs, time to do other things and prevention of social networking addiction - protecting own's safety and privacy by keeping personal information as private as possible and not disclosing any more personal information than is necessary - interpreting SMS messages the tone of the message (e.g. use of bold letters and symbols) correctly - recognising when (s)he is being threatened and know how to deal with it, for example whether to ignore, report or respond to the threat.

WHY SHOULD EDUCATORS IMPLEMENTING PROGRAMS OF LEARNING WITH MOBILE DEVICES PAY ATTENTION TO MLEARNING LITERACY?

Educators embracing programs that make use of mobile devices for learning need to ensure that students' mlearning literacy are adequately addressed, particularly the 'technical and functional skills' perspective, in order to achieve better learning outcomes. Studies have shown that one of the barriers for both staff and students to using mobile devices for learning is the lack of awareness of the functionalities of the mobile device being used and limited knowledge of the academic applications of the mobile device (Belanger, 2007; Goodchild & Chenery-Morris, 2011; Stiler, 2007). For the students, when technical skills related to using the mobile device and its applications become automatised, it will alleviate cognitive load enabling the student to focus his/her working memory on the task at hand rather than on the technical aspect of the machine and/or software. This is in accordance with John Sweller's (1988, 1999, 2005) cognitive load theory which states that there are three types of cognitive load

1. *intrinsic cognitive load* is the inherent level of difficulty associated with the complexity of the interacting elements of the instructional material that has to be processed simultaneously in the working memory. People have limited cognitive processing abilities and can process 7 ± 2 elements at any one time.

2. extraneous cognitive load is dependent on how the instructor presents the learning material to the student and is the load imposed by poor design of the instructional materials .

3. germane cognitive load, also implied as "effective' cognitive load is the load imposed by instructional materials that fosters the process of learning e.g. motivational learning materials. Germane load is relevant whereas extraneous load is not. Teachers can change instructional materials to reduce extraneous load and increase germane load.

By being skilled technically with working the features of the mobile device in use, the student does not have to be distracted by the technology and could focus the working memory on learning the material and undertaking the task at hand. It has often been said that educators should let the pedagogy drive the tool. I would argue that it goes both ways, meaning that knowing about a tool and what it can do to support pedagogy is just as important. It means exploring the mobile device and knowing how the functions in it can support pedagogy. Just as a content expert will be able to move the knowledge around to explain a concept in a variety of ways, a student who knows the mobile device being used and its functions/applications well could make use of the available features, singly or in combination to convey his/her understanding better. For example, the constraints of writing a report in a PDA or mobile phone means that it would be better to capture images of an experiment with embedded short captions or verbally explaining the experiment while video recording each stage of the experiment. The student could decide to capture a series of images and Bluetooth them to a desktop in order to complete the report by using movie making software to create a multimedia presentation. This type of flexibility

promotes the ubiquitous interactions of ICT devices, as discussed in the Introduction section of this paper, to achieve a desired outcome. Part of the mlearning literacy that students need to develop is an understanding that the mobile device is a technology that does not stand alone and that for better learning outcomes, it is necessary to be able to select the best combination of technologies that could further support the learning with the mobile device at hand. Being mlearn literate means having the ability to make decisions about which other devices (mobile or otherwise) that are available to the learner that are able to support better learning. It could mean capturing the data informally and while on the move and processing them later with other technologies. In addition, familiarity with a range of applications could further enhance the capturing of data and/or demonstrating understanding.

Apart from the technical skills, well developed mlearn cognitive and social-emotional skills that are indicated in Table 2 will prepare students to access information and social websites using their mobile devices intelligently. This is important as the personal ownership and ease in portability of mobile devices mean that the frequency of accessing Internet sites potentially increases during informal learning times.

What are the implications for teachers?
There is a role for teachers to foster the development of mlearning literacy in all students. With the vast majority of school aged students owning mobile phones and other mobile devices, literacy associated with using and learning with mobile devices should be an integral part of digital literacy education even for schools without mobile learning programs. This will ensure that the informal learning and socialization of students with mobile devices are safely and sensibly conducted.

An implication of mlearning literacy is that, similar to the argument for mLearning literacy in students, teachers need to be similarly literate if they are to be involved in mlearning programs. This means developing adequate technical skills and knowledge of the mobile device used in the school or tertiary institution. Good technical skills and knowledge of the affordances and constraints of the mobile device will enable the teacher to design pedagogically sound uses of the mobile devices. Research has shown that one of the main barriers of effective and sustainable integration of ICT in schools is a lack of technical skills and knowledge (Hew & Brush, 2007; Mishra & Koehler, 2006; Ng & Gunstone, 2003;Tebbutt, 2000) in teachers. In order to be mlearn literate technically, teachers must be provided with professional development and time to practice and familiarize with the technology. Similar to students' learning, when teachers are technically skilled, they can focus on the pedagogy and content that students need to learn with the mobile devices. In this way, they can increase the germane load of students through the preparation of engaging and relevant activities.

In schools where formal learning using mobile devices as the technology support tool, the teacher needs to structure a series of small but explicit exercises that draw on the different affordances of the mobile device being used. For example with a PDA, a systematic set of simple exercises that allow the students to explore the different affordances of the device would allow student to build up their understanding of how the device could be used for learning. For example, exercises that take them through data entry, using the 'sum' and 'average' functions in a pop-up menu, writing formulae for sum and averages as an alternative, charting different graphs for different purposes will provide them with the opportunity to learn about the software before applying to problem solving and to understand the constraints of mobile Excel in comparison with desktop/laptop Excel.

CONCLUSIONS
Using technology requires practice and opportunities to familiarize. The more use of the mobile technology, the more familiar teachers and students will be with the functions, applications, issues and responsibilities associated with its use. When familiarity occurs and the knowledge and skills gained from this familiarity are stored in the long-term memory, the use of the mobile device becomes intuitive and automatised. When this happens, the focus of learning would be on the tasks at hand and content to be learned or developed. The attention to learning will not be split because of the need to learn the technical skills at the same time. The learning is at the forefront of the learner's working memory where its limited capacity can draw on the expertise stored in the long-term memory to process the information at hand. It then becomes truly learner-centred.

The development of mlearning literacy may require both the teacher and his/her students to be technology-centred for the initial periods of time. As students develop expertise with operating the device, the focus on learning with mobile devices become learner-centred. When fluency with mlearning literacy recedes to the background, theories of learning with mobile devices come to the forefront – the engagement of learners with the learning materials

Lankshear and Knobel (2003) assert that a shift in mindset is necessary to embrace 'new literacies' education in order to take into account the changes the world has experienced during the information technology revolution. They advocated new literacies to the new types of knowledge associated with "digitally saturated social practices". The literacy discussed in this paper would be an integral part of this 'new literacies'. Mobile devices that have

access to the internet promotes learning that is 'always on'. A large proportion of this learning is carried out in informal settings outside of formal class times. mLearning literacy empowers learners to use the technology sensibly, it is one of the life skills-based literacy that should be taught well.

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mTeaching

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Abstract

The focus on mLearning has created a welcome opportunity to engage with the needs of learners to have access to multiple sources of information from multiple locations and to juxtapose different experiences and views so that they are not subordinated to teacher-defined knowledge. However, at the same time, views of mLearning largely neglect a theorised positioning of teachers even though they are major agents in the creation of the contexts for this kind of learning. By singling out learner control and informality of approach, such approaches to mLearning fail to provide a theorised basis for the integration of learning with mobile devices in formal education. As a consequence, such approaches fail to show teachers what they can do to shape positive mLearning programs. However, we can develop a model of mTeaching that is consistent with and complements central tenets of mLearning. Based on work done in a variety of primary and secondary schools in Australia, this paper presents a model of the central principles of mTeaching. The model addresses the relationships, procedures and content required in a view of mTeaching. Within each broad category various sub-types (e.g. relationships with self and relationships with others) are outlined and connected with different phases, purposes and contexts of teaching/learning relationships. I show how this view of mTeaching enables the tensions between the demands of pedagogy and the demands of technology to be reconciled and address the different contributions to the realisation of the mTeaching/mLearning connection that can be made by teachers and learners.

Author Keywords
mTeaching, mLearning, pedagogy

Introduction
The first reference in the literature to the term 'mobile teaching' appears to be in Kukulska-Hulme and Traxler (2005). Although framed in their chapter, the concept is not explicated. Later, Dickerson and Browning (2009:59) asked:

1. What does an educator need to know about mobile technology instruction?

2. How does the though process change through the use of a mobile technology delivery?

3. Where does the mobile technology instructor begin in his/her analysis?

4. With so many technologies and capabilities on the market, how does one go about selecting a mobile technology?

Despite asking these questions, Dickerson and Browning do not go on to offer a pedagogy of mobile learning – rather they offer ways of selecting technologies for their fit with various approaches to teaching and other criteria such as cost.

Framed by a Community of Inquiry approach, Garrison (2011:128) argues for "the importance of and central role that teaching presence plays in the development of a community of inquiry". Further, he identifies design, facilitation and direction as central aspects of "teaching presence", leading to an argument (p. 129) that "Moderating and shaping the direction of the discourse are important educational responsibilities that must be properly balanced as learning progresses." In an exploration of four different case studies of mobile learning, Stewart and Hedberg (2011:273ff) identify three dimensions of a 'pedagogy of mobility': *technical interest* that encompasses an asymmetrical relationship between an expert and a seeker of information; *practical interest* that "involves creating opportunities for discussion, negotiation and formulation of consensus" and *emancipatory*

interest that is "symmetrical with the teacher and student operating as co-learners". Beetham and Sharpe (2007:4) went so far as to claim "In rethinking pedagogy we are not trying to define some new aspect or area of the discipline: we are trying to rearticulate the entire discipline in this new context."

These views present both mobile learning and mobile teaching, but fail to articulate the relationship between them and, therefore present a theoretical and practical dilemma. Learning with mobile devices needs to consider BOTH how the learner approaches the use of the devices in the learning task AND how the teacher structures the overall learning experience to consistently maximise the benefits of the experience.

Rodrigo (2011) has captured the dilemmas attached to these debates quite neatly. "Research now shows that successful learning needs to be active and engaging, connect to the students' prior knowledge, and simulate real-world experiences. The promise of mobile learning is the ability to engage students with creative and/or sophisticated content learning activities on their multimedia production devices. This is worth repeating: **To achieve the promise of mobile learning, we have to stop thinking about these powerful mobile multimedia devices as only *consumption* devices and get students using them as *production* devices."** While focussing on the nature of mobile learning, Rodrigo actually calls for developments in mobile teaching "we have to … get students using". Despite including the term 'mobile teaching' in her article title, she does not label what she is calling for 'mobile teaching'.

Jung & Latchem (2011:7) argue for "the all-embracing term 'e-education' … [as] … this term also reflects the fact that ICT can serve both teaching and learning requirements. As Baggaley (2007) observes, using such terms as 'e-learning' diminishes the role of the teacher, the person who is ultimately accountable for the learning." They go on to elaborate a general overview of the teaching relationships in such an approach, but they do not lay out the specific and different strategies that teaches can use in managing e-education. Their general model offers broad concepts, but not the specific strategies that would form the teacher's repertoire. Ottestad (2010: 489) reported that "the Finnish case arguably shows that autonomy and local ownership of definitions of important interpretations of curricula together with influence on professional development can provide better structures for pedagogical innovation with ICT." Nevertheless, mobile teaching remains the silent, un-theorised element in learning with mobile devices (see Smyth, 2011). Park (2011) uses Moore's (2007) transactional distance theory to highlight the importance of dialogue between teachers and learners, but does not proceed to identify the specific strategies that teachers might use to promote such dialogue, devoting attention instead to the general factors that might overcome or reinforce such distance. Articulating a clear view of what mTeaching strategies might be and how they could relate to one another is a beginning to solving this dilemma and is the task of this paper.

Framing mobile teaching

mTeaching and mLearning are not opposites, but complementary elements in a necessary relationship. The key leap in the thinking needs to be the theorized connection of 'mobile' and 'teaching'. Many articles in recent volumes of journals such as the *International Journal of Interactive Mobile Technologies* and the *International Journal of Mobile and Blended Learning* mention terms such as 'mobile teaching and learning' or 'mobile learning and teaching', but in most of them the reference to 'teaching' is redundant as the focus is all on the learner and learning. This focus on the learner is welcome but incomplete. It is the relationship between teaching acts and learning acts that needs to be foregrounded in a view of 'mobile teaching'. In part, this reflects the view of teaching as practice and the dimensions that are implied in that approach in the work of scholars such as Ball (Ball, Thames & Phelps, 2008; Ball & Forzan, 2009). Figure 1 presents an initial attempt to create a view of the relationship.

The view of mTeaching begins by identifying three broad elements of 'classroom' processes. In this context, 'classroom' is short hand for any teaching-learning relationship where the responsibility lies with the teacher for initiating the construction of the relationship. Clearly it is possible in the context of learning with mobile devices for that relationship to occur in multiple contexts so that links are created between the formal classroom and other contexts of experience such as home, the playground or excursion sites. However, in this view of mTeaching, the teacher-learner relationship is also transcended to incorporate the roles that others such as adminstrators or support staff may play in the overall teaching-learning process. Thus, 'classroom processes' and the view of mTeaching that is attached to them are embedded in wider educational/institutional contexts and the view of mTeaching has implications for the overall organization and processes of the institution, for example extending to decisions that libraries may make about how to design learning spaces or how cabling, printers, data projectors and wireless points are installed – and the budget such innovations.

The three elements of the processes involved in mTeaching are relationships, procedures and content. Thinking about mTeaching involves consideration of the relationships that are involved - both between the teacher and the learner and between the learners themselves. The relationships between the people involved are distinguished from the procedures of any particular activity. In the context of learning with mobile devices, the procedures encompass two elements. The first of these are the procedural aspects of the technology itself, i.e. the learning

about the particular technology or devices involved in any given activity (which will also involve the relationships between those devices since it would be unwise to assume that any single device will be able to achieve everything that either the teacher or the learners will need). The second of the procedural aspects are the steps in the activity itself. These steps may or may not involve any particular device. For example, if an activity is to involve the use of a mobile device to record interviews with various participants, the first step in the activity might be a brainstorming activity during which a whiteboard might be used to record suggestions for themes in the interview or issues in the interviewing process. These elements are different from the third element, content. Content involves both consideration of the intellectual challenge of the learning and consideration of the quality of the resources that may either be available as 'input' to the learning and the quality of any 'outputs' that learners are to produce.

Although I have presented these elements as if they are separate, the very fact that they are shown as integrated within the concept of mTeaching should be taken as an indication that the three elements are part of a single ecological complex of related elements, each influencing and being influenced by the other elements. The nature of the content that will be explored is deeply implicated in the procedures and processes that will be used in that exploration, which in turn cannot be separated from either the various interpersonal relationships that the processes entail or the ways in which technology can be used. It should be clear from this quick overview, that teaching and learning are not separate elements. The learning with the mobile devices (whether receptively or productively) needs to be understood as shaped by the contexts and opportunities for that learning created by the 'teacher' and the institution. Becoming specific about what this view of mTeaching entails helps to clarify the relationships between teaching for learning with mobile devices and teaching in other technological environments.

Figure 1. Elements of a view of mTeaching.

Elements of mobile teaching

I now turn to the various elements of mTeaching in greater detail. In any view of teaching, the relationships between learners and teachers as well as those between the learners themselves are central to the success of the experience. As Killen (2009:25) argues, "You should not expect students to be engaged in meaningful learning if the environment is not supportive, encouraging and focused on learning. … the learning environment … includes the interactions and relationships between and among students and teachers …". In the context of learning with mobile devices, the learning environment includes the mobile devices themselves and any of the other members of the suite of technologies that will be engaged in the learning activities.

As a teacher interviewed some time ago pointed out:

> You start from bottom, use it for a purpose not for the sake of using it…money spent does not drive it to work. It has to come from the classroom and kids' needs. (staff#19) (Ng & Nicholas, 2007:187)

Thus, in the aspect of 'personal introductions and networking' the relationships that need to be considered include relationships as they are mediated by the technology. For example, if teams and groups are to be used, then ways in which members of those groups will introduce themselves to one another are an important teaching issue. For classes that exist in a blended environment, much of the initial introduction may occur in face-to-face settings, but then the transition from face to face communication to digital communication will also need to be managed. Issues such as whether the devices will include pictures of the people who communicate will shape how the communication is perceived. Equally, planning will be necessary in relation to issues such as how the essentially multimodal nature of communication will be negotiated in a digital context where not all elements of the communication may be present. If the mobile communication is to be via text, then part of the teaching will need to address which language varieties are to be used, what issues are involved in signalling constructive relationships (do emoticons play a role and, if so, when?) and how to resolve moments of miscommunication. Without attention to these matters, then it will be very easy for miscommunication to occur and for the learning experience to become ineffective. One possible solution is to restrict the extent of the digitally-mediated communication so that all (or most) acts of intricate negotiation occur in face-to-face settings, but this will not be either possible or desirable in all situations of learning with mobile devices. In consequence, mTeaching will need to plan and prepare for the ways in which relationships are established and maintained in complex and varied communicative situations.

As argued in Ng and Nicholas (2010:240), the learning sequence where distance (mobility) and technology are integrated requires a progression from structured, whole group learning through structured team learning to individual open learning. This approach was used in various learning experiences to permit learners to get to know one another and to practise their involvement in shared learning tasks prior to opening up both the learning goals and learning processes to much fuller control by the learners.

Implied in the above comments is the separable aspect of how learners manage their own learning and relationships. 'self-management and evaluation or critique'. There is a need for self-management, but in most humans, self-management of any of these aspects is a hard-won capacity. In consequence, learners will need to be taught how to evaluate and critique both their own learning and interaction and those aspects in the people they are learning with. This feature is not unique to learning with mobile devices. It is a core element of the role of education, but given the potential of mobile devices to enable learning that while engaged with others is separated from them (for at least some of the time), there is a need to address this aspect even more explicitly in this than in other educational contexts. Depending on the situation, this can include issues such as when to turn the device on or off, when it should be turned to silent mode, when a particular task is appropriately done on the particular device and when it should be done in another matter or whether there is a need to take a break from use of the device for health and safety reasons. Teachers in various studies have made use of multiple strategies, but one teacher in a study reported how students with literacy difficulties needed to be progressively introduced to the capacity of PDAs:

> *They just wanted to write the letter by hand, which they struggle to do anyway. But once you introduce them to the predictive part, that's really good but it doesn't work when they don't know how to spell the words. So it has a catch, there are positives and negatives. So I let those kids write it by hand and I corrected it and then they wanted to have a go and they feel more confident in using the PDA.* (staff#11) (Ng & Nicholas, 2007:9)

The third aspect of relationships is 'educational negotiation and quality of processes'. A key element of this will be matters such as discussions. To the extent that mobile devices are used as the primary tool of communication (for at least some of the time) then mTeaching will need to consider different kinds of discussion and how they are

conducted. To the extent that the mobile device is the tool for communication across distance, then processes of discussion that acknowledge others' contributions and signal explicit relationships between one contribution and another may need to be developed. For example, in face-to-face communication, agreement and turn-taking can be signalled with a nod of the head and stress on particular words, but if the mobile device is being used as a text-based form of communication, then those particular resources of spoken face-to-face communication are not available and alternatives such as some version of 'I agree with what you just said, but …'. mTeaching will need to consider and prepare learners for these kinds of situations. In contexts where the mobile devices are part of a shared physical environment, then issues of who looks at which screen and which items are shared with other participants are all part of what mTeaching will need to consider in order to make mLearning effective.

In Figure 1, I have identified two further sub-components of 'educational negotiation and quality of processes'. The first of these sub-components addresses the issues associated with distinguishing between the drafting or development of thinking and the publication or sharing of ideas/materials in a more final format. The significance of the distinction between working to prepare something and presenting it as 'published' is a vital element of the structuring of the learning process. The relationships between participants in planning and preparation (where the participants are often equals and have responsibility for supporting one another) and those between producers of finalized materials and unknown (or more distant) audiences have crucial implications for what needs to be made explicit and how material is organized. mTeaching has to develop in the learners a sense of the specific characteristics of each of these stages, and what they may look like on any of the suite of potential technologies that learning with mobile devices may entail.

The second of these sub-components engages with issues around 'ethical sources and uses of information'. Entailed in this dimension of mTeaching are issues that are discussed under the broad headings of plagiarism and bullying. More concretely, they require the development of practices for searching, record-keeping, referencing, claiming and sharing responsibility for work and decisions about what to share about other participants. If part of the process of learning involves the tentative exploration of ideas with others, then that suggests shared moments of vulnerability. Those moments of vulnerability (either intended or involuntarily captured through e.g. camera functions built into many mobile devices) are ethical challenges. A part of mTeaching is, therefore, a series of practices and learning experiences that model or explore the ethical dimensions of easily obtainable and transmittable information.

It is easy to see how the above dimensions of relationships relate to one another. Implicit in the way that I have described many of them is a view of the second element of mTeaching, 'procedures'. I have made frequent references to group work, to the options for either blended or fully digitized communication, to a view of learning that builds over time through multiple drafts and through the exploration of potentially unfamiliar material – all of which are possible options within mLearning. Contributions such as those of Rodrigo (2011) show that all too often learners experience the use of mobile devices as tools for the consumption of information rather than for the creation of new understandings. Her point is to call for a pedagogy for these devices associated with production, the kind of total rethinking of the pedagogy that Beetham and Sharpe (2007) called for and Stewart and Hedberg (2011) partly characterised. The challenge is to make that pedagogy explicit – in relation to both the use of the devices and the steps in the specific tasks. As I will argue, this challenge entails moving well beyond the classroom to consider a wider set of institutional practices and relationships.

While technology and the design of tasks cannot be separated, for the purposes of characterizing mTeaching, technology and task design must be treated as separable. If mobile devices are to be used effectively in mLearning, the learners must have a good understanding of what they can do. No matter when learners were born, they do not come hard-wired with understandings of digital devices and the understandings that they do have are not evenly distributed. In consequence, mTeaching will need to develop procedures to familiarize learners with the various affordances of their particular devices. This cannot afford to be a rote-based series of technical exercises, though under appropriate circumstances it can involve the practising of specific skills so that learners can use them without having to think too hard about what to do. The aspects involved here may include any and more of where files are saved, how to switch between applications, how to resize objects, whether images can be sent with text messages, which word processing applications can be used on the device and how to print files. Which ones will be important will vary according to which of the purposes (identified as sub-components 'for learning support, for assessment or for administration') are involved.

Learning support may involve the library in providing access to resources in specific formats or creating links to specific resources/references in particular ways. Learning support might also extend to issues such as tutorials on referencing conventions or exploration of the various ways in which material can be presented. The differences between how material would be organised if presented as a PowerPoint slide or on a website or in a wiki all entail different understandings of what it is possible to do and require different capacities in the learners to control their own uses of their devices. The second sub-component of learning about technology (using the technology for assessment) may entail attention to referencing and originality or ways of labelling files. It might involve training

on specific applications that can be used for checking originality, or might involve specific work allied to the publication phase of quality processes as learners specifically look to refine their work to achieve the best possible assessment outcome – looking at screen layout, image size, readability issues or the sequencing of material may all by part of this learning – and will require specific intervention either from the teacher or mediated by the teacher. It may connect with other elements of the procedures and relationships because of the distinction between potentially shared material in a drafting or pre-publication phase of work and what may well be single-author work that is required for assessment. The third sub-component of the mTeaching of procedures about technology (for administration) may well have more implications for teachers alone than for the relationship between teachers and learners. For teachers, the implications of learning with mobile devices for record keeping, for processes of material distribution and collection and for the management of the overall learning processes are profound. To the extent that learning with mobile devices is a distributed activity, then mTeaching entails a much greater attention to distributed processes with different learners doing different things in different places and possibly at different times. While elements of this are familiar in areas such as the management of group work in face-to-face classes, they are likely to form a more substantial element of mTeaching processes (to be ubiquitous?) than they are in face-to-face teaching. Hence, the balance of the teaching process shifts when mTeaching is involved, but it is not a totally different process from what might be involved in other forms of teaching.

The second aspect of the 'procedures' component is 'steps within the task'. These steps can involve either or both or various combinations of individual and group activities. mTeaching addresses the planning and organisation of these different tasks and the relationships between them. There are clear connections with the aspect of 'educational negotiation and quality of process', but the emphasis in the procedural steps is on the more logistic nature of the sequence of the different activities. Teachers will be required to arrange different activities in a sequence that makes sense and to think about the nature of the activity in relation to its place in the sequence. So, a task that might involve relatively little material location and construction would enable that task to be placed early in an activity sequence at a time when more interaction and brainstorming might be appropriate. In contrast, a task that might involve more integration of textual and visual material or might involve the use of both verbal commentary and visual imagery would most likely be better suited to a later step in a procedure so that students would have an opportunity to plan, edit, draft and re-draft their material. The complementary part of planning these procedures in mTeaching would be where the teacher organises the range of resources that might be required to support different steps in the procedure, which might also include assessing whether a particular location is suitable for the activity because it either does or does not have wireless access. The connection here with other procedures should be obvious – if wireless access is restricted, then there are institutional implications for how appropriate forms of wireless access or (restrictions on applications) need to be provided to enable the appropriate range of learning activities to occur.

The third and last component of mTeaching is the content itself. The first aspect of this component is the actual 'sequence of concepts' for which the teacher plans engagements. From an mTeaching perspective, the teacher will need to consider in which sequence the various content concepts will be introduced. This is not to suggest a lockstep syllabus nor to deny the capacity of learners to engage with multiple concepts at different levels and in different ways. Clearly groups of learners are not homogenous – they are neither all 'at the same level' nor do they all have the same learning style. One of the great advantages of the awareness of learning with mobile devices is the acknowledgement of the heterogeneity of learners accompanied by the opportunity for learners to access sources and kinds of information that a teacher has not envisaged. In no way does a view of mTeaching undermine either of these acknowledgements. Nonetheless, mTeaching acknowledges that a teacher needs to prepare a series of activities in ways that have a logical flow to them. These issues have a long history in fields such as language learning and teaching (Breen 1987a, 1987b). The notion of a procedural syllabus recognises that what is actually taught emerges only after the learning process has been gone through. Nevertheless, the teacher is still required to select, organise and sequence (Stern 1983) a series of engagements with the content, even if those engagements are only the beginning rather than the comprehensive definition of the learning process. Stern's concepts of selecting, organising and sequencing apply mainly to the 'input' or consumption side of mLearning. However, there is an equally significant 'output' or production side that is associated with the sequencing of content. In some way the sequencing of content has to provide the learner with a sense of both learning and having learned. The procedures within the task have a role to play in this, but in the content area, the mTeaching dimension is where the teacher looks to ensure that as the learner progresses through the various steps in the task or through various tasks, their understanding of the material that they are engaging with grows and they are enabled to do more powerful things with the experiences that they have – this is, after all, the LEARNING part of mLearning that mTeaching is fundamentally trying to scaffold and promote.

A specific aspect of the selection and sequencing of the content that will need to be addressed in mTeaching is the complexity of the concepts that are being presented as the basis for learning experiences. At the most banal of levels, it would be inappropriate to present to children aged 4 material that required them to theorise about Einstein's theory of relativity. There are clearly examples where the idea of conceptual complexity are much less

clear and where mediated engagement will provide ways of appropriately learning (from) conceptually complex material, for example moral issues about fairness. Nevertheless, all forms of teaching require teachers to engage with the question of how difficult any proposed concepts will be for their students and to plan processes that address the perceptions of complexity. This issue is all the more significant in mTeaching because the very heterogeneity of the materials that learners will be able to locate using their mobile devices means that simple and singular learning sequences from 'simple' to 'complex' are far less likely to be part of the learning process. This means that in mTeaching, teachers must be much more conscious of how they recognise and respond to complexity in productive ways since they will be much less in control of the complexity of their learners' experiences than they might otherwise be.

The third aspect of content that mTeaching needs to address is the 'quality of the products' that learners either locate or produce. Quality is possibly and even more contentious issue than complexity – its dimensions are debated and judgements diverse. As an issue quality intersects with issues such as assessment, ethics, extent of understanding and audience. One dimension of quality links back to a sense of learning having occurred – in some way the understanding should be of a higher quality or appropriately greater complexity or greater utility after the experiences. The mTeaching dimension of this focus on the quality of products as part of the input to the learning process requires the teacher to select or construct products that will be suitable for the learning task. This may involve technical skills such as formatting image products so that they can be viably presented via mobile devices or it may involve critical evaluation and selection of specific images to choose images that are best suited to represent the concepts underpinning the learning process. As part of the production side of the relationship, quality will connect with the needs of the audience and the mode of presentation. Again, mTeaching will involve planned engagement with these issues so that the learner gains sufficient control of the technology (suite of technologies) and awareness of relationship to audience and purpose that the produced 'product' will be of an appropriate quality.

Conclusions

As the above discussion has revealed, the three components of mTeaching are connected at a number of levels. mTeaching decisions in relationship to one of these components will have ramifications for other components. The components are analytically separable rather than separate; their enactment in mTeaching will need to be integrated. Further, the various components and aspects of mTeaching do not constitute an approach to teaching that is categorically different from other teaching. Neither is mTeaching a non-thoughtful instance of general pedagogy.

The affordances and challenges of mobile devices create specific opportunities and challenges for learning and teaching. They highlight the specific nature of digital communication (including its diversity) and therefore make specific demands on mTeaching to think about the communication processes of teaching and learning in ways that are not so specifically foregrounded in other modes of teaching and learning. Mobile devices offer multiple opportunities for learners to engage with materials that have not originated with the teacher and to engage in communication that is not directly mediated by the teacher. By and large, these are good things. However, they present specific challenges to the creation of productive learning environments and the interpersonal relationships within those environments.

'Classroom management' is not an unknown phenomenon in teaching, but the specific requirements of the management of mobile learning environments cannot be captured simply by applying general classroom management models – in part because large parts of those environments may be outside the standard classroom. As a light-hearted example, the management of mLearning may involve regulating what learners do in bed at night after the lights have been turned off in case they are tempted to never stop looking for more material to include in their work or inclined to continue to send material to their peers until all hours of the morning!

As I hope I have shown, mTeaching is not a construct in opposition to mLearning, but instead a central element in both theorising and implementing productive experiences in learning with mobile devices. We need to continue with the elaboration of elements components and elements of mTeaching so that we are in a better position to assist teachers to make better use of the potential of mLearning.

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Supporting creativity in teaching and learning of history through small-group production of mobile, location-based games

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ABSTRACT

While much attention in research on computer games is about how they support learning processes, relatively little attention has been directed at how students themselves can create learning games for each other. The present study investigates how students are able to create mobile, location-based games for each other to facilitate learning of history. A learning scenario designed in collaboration with a history teacher, has groups of students create a game, play another group's game and create a digital media product about what they learned by playing the game. Qualitative methods, namely video, observation and interviews, were used to gather data from a field trial of the scenario. Based on initial analysis and some initial observations, which are presented in this paper, we are convinced that this is a motivating and rich way to learn and is a promising approach worthy of further study.

Author Keywords

Student-created location-based games

INTRODUCTION

Using computer games for teaching and learning has gained popularity in schools and academia, and computer games have also become increasingly studied for their educational potential (see e.g., McFarlane, Sparrowhawk & Heald, 2002; Kirriemuir & McFarlane, 2004; Shute, Rieber, & Van Eck, 2011). Most of the research focus in the scholarly literature is on various learning effects of students playing computer games. Similarly, many of the courses that deal with design and creation of computer games are courses in computer game design itself, rather than using the game design process to build games to learn other curriculum. One example that looks at both is El-Nasr and Smith's (2006) two case-studies of students in computer science learning computer skills through modifying, or *modding*, existing games by working with the game engines, where they find that game development involves many different skills other than programming, ranging from artistic to mathematical concepts. Lim (2008) raises the idea that students in school should be allowed to design their own computer games based on their own interpretations of the curriculum, as a way to create more engagement with their own learning processes. Prensky (2008) agrees that in order for educational games to be successful the students themselves should indeed create them. In particular, he suggests that students could work with creating what he calls "*mini-games*" (Prensky, 2008, p. 1006), which are contrasted to professional, commercial game productions, and created by groups of 2-3 students doing their own curriculum-based research with an advisor, where the games usually take around one hour to complete. Prensky cites young people's experiences with different digital tools used for creating games as one of the prerequisites for this. As an example of these kinds of tools, Resnick (2007; Resnick, et al., 2009) describes Scratch, which is an online system where students can learn to program interactive, online media products such as games, stories and animations, designed to foster creative and systematic thinking.

Within the field of Mobile Learning, there has also been a research interest in whether and how games on mobile devices may be utilised for various purposes. For example, Mitchell (2004) has carried out field research regarding the motivational potential of mobile games. She found, among other things, that devices that had the potential to load games were perceived more positively than devices that could not, and that educational games on mobile devices should appear as "polished" as commercial games. Thomas, Schott and Kambouri (2004) expanded usability guidelines from design of digital games in general, to how they can apply to mobile, educational games. Göth, Häss and Schwabe (2004) describe the development of their prototype of mobileGame, a collaborative and competetive game for new university students to get to know the campus, and Angarita et al.

(2005) provides an account of an attempt to bring educational games into a mobile book system for continuing medical education. Miettinen and Mattila (2006) describe their work with designing a 3D virtual world game, Virtual Snellman, for the mobile phone. Fotouhi-Ghazvini, Robinson, Earnshaw and Excell (2008) report the implementation and evaluation of a mobile game, called MOBO City, designed for technical language learning in Iran.

In this paper we present a learning scenario based on location-based games and study its implementation in a field trial. The study is a continuation of a series of studies with the mobile and location-based technology called SILO, where the focus previously has been on usability (Wake & Baggetun, 2009), on how to integrate mobile, location-based games with classroom tools and activities (Baggetun & Wake, in preparation), and on game-player interactional organisation and accomplishment of location-based games (Wake, Guribye & Wasson, 2011). While the focus of these studies has been directed at various aspects of game play, *in situ,* the SILO system is also designed for the rapid creation of location-based games. Thus, we have designed a scenario, Bergen History through Mobile Games, where students at an upper secondary school in Bergen, Norway use SILO to create location-based games tied to the history of Bergen for each other to play. This paper focuses on how the students were able to accomplish game creation where both curricular materials and aspects of the city are an integral part of the game, and where the location-based gaming experience supports the creation of a media product that shows what they have learned. The concept of creativity is inherently ambigous, and no complete definition is offered here, but by focusing on "creativity" in this scenario we want to highlight how the students created products (a game and a presentation), rather than reproducing something, using an unfamiliar digital tool.

The paper is organised as follows. First, we present the design of the Bergen History Through Mobile Games scenario that comprised three activities, including a description of SILO, the technology for creating the games. Second, we describe a field trial of the scenario, followed by the research design, including data collection and analysis methods, we used to study the field trial. We conclude with our initial observations.

THE BERGEN HISTORY THROUGH MOBILE GAMES SCENARIO

To explore the creative writing of location-based games for history learning, a scenario involving different digital tools and activities was designed in collaboration with a history teacher. The scenario, which combined activities in different contexts, that is, in the classroom and out in the city of Bergen, comprised three activities: Game creation, Game playing, and Digital Media Product development. First working in groups, the students would first work creatively to tie historical themes in Bergen's history to actual places in Bergen, before they would translate this into a location-based game for their peers to play. Second, the students would give their game to the other groups to play. Third, after playing the game, each group was to re-create their experiences with the different themes in the game into a digital media product, combining images, video and sound captured while playing the game.

Through game creation, the students were to combine features of the real world, represented by the different locations in the city, and their interpretations of the different written sources available to them, into a game narrative that would be discovered by the recipients as they played the game. The gaming aspect was very much about finding the different relevant locations in the game by following the narrative. By creating a digital media product, the students reflected over what they learned about Bergen history by playing another group's game.

Theme: WW2 in Bergen

The scenario was designed and planned in conjunction with the teacher, both in terms of the theme and how to use the available technology for creating and playing the location-based games. The participating teacher not only taught history, but was also the e-contact at the school with expanded responsibilities related to the school's ICT-systems, and helping the other teachers with digital technology. She chose Bergen history during the 2nd World War (WW2) as the theme for the game as 1) it fit with the current curriculum, which was between "older" and "newer" history, 2) the school building was occupied by the German military during WW2 and 3) the availability of physical locations related to the theme around Bergen. The teacher identified themes and events related to 16 locations in Bergen during WW2. Examples of the themes include: 'The attack on Bergen on April 9th, 1945. Where?', 'The Printed Press of Bergen during times of crisis: Illegal papers', 'The history of the Jews in Bergen', and 'Food and rationing'.

Game Creation

The class would be divided in half, each half being given 8 of the themes. Each half would further be divided into groups of 3-4 students. Each group was asked to choose 6-8 of the themes and events, which would form the basis of their game.   How they were to order the locations in the game, and what they chose to write about each, was up to them. They were also free to discover and create places and events by themselves. Each location was also tied to a theme.

A set of documents was made available through their Learning Management System. These included a description of what they were to do, a list of learning goals, a description of how the activity was tied to the five basic

competencies (a key aspect of the most recent reform of Norwegian education), an explanation of how they would be evaluated, a list of resources and internet-based sites with relevant background, and a user manual for SILO. A collection of texts of historical relevance to the theme, such as magazines and books were made available in the classroom. The students were also encouraged to seek out local museums, the public library of Bergen, and the school library.

Game Playing

Each team was to play the game they received, moving around Bergen and learning about the historical sites in the game. The students were encouraged to bring cameras with them, or to use the cameras on their private mobile phones, and record various aspects of the places that they visited so they could use it as source material for creating a media product after having completed the game.

Digital Media Product

The digital media product the students were to create after playing the game could take the shape of a video or film, a wiki or a blog, or a web page. It was decided that the creation of a digital media product would not interfere too much with the fun aspect of playing of the game, and would increase the learning potential of the game. As the game application paused automatically at each location they found, knowing they would have to include the location in their digital media product would increase the attention they paid to the site.

Technological resources: SILO and other digital tools

The students are provided with SILO, which is a web-based tool we have developed for rapid development of mobile, location-based games (see Wake & Baggetun (2009) for details). SILO was created in Django, originally a content management system (CMS) for publishing newspapers digitally. SILO comprises a game editor and a phone application (for phones running on Symbian S60) for playing the game. Using the SILO game editor, see figure 1, a user ties a storyline to geographical places, defined by GPS, by clicking on a map. The digital map on which it builds is openstreetmap.org.

To create a game the user first adds a name for the game, start and stop dates, and participating groups (outside of range in the screenshot in figure 1) before adding points of interest (POI) that define the geographical locations to be included in the game. The user creates a POI by clicking on a place in the map and entering a text, which usually describes the place. Additional clues/hints necessary to find the next POI can also be included. The user can also attach an icon to the POI. When a POI has been created, the user can add another, and so on, until all the desired locations have been added to the game. All the information, including the map, the route, the text, icons and hints are then assembled in a zip-file, which can then be transferred to a mobile phone.
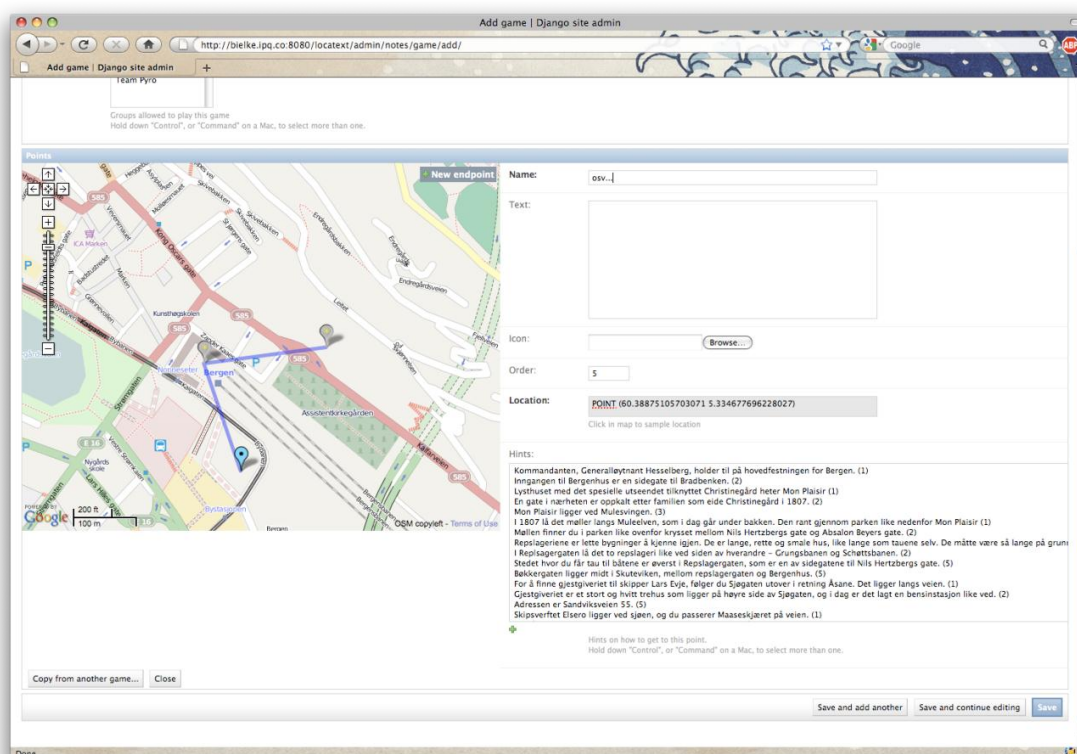
Figure 1. The SILO interface

The phone application (see Figure 2) interprets the data, and converts it into a game to be displayed on the phone. Displayed on the phone is the map, an optional marker displaying one's current position on the map, a track displaying the history of movement, and a bar (on the left side) displaying the icons of the places that the participant has visited. Additionally, there is a distance meter (shown in red numbers), displaying the remaining distance to the next location, which is updated every five meters. When the participant moves within a zone of 30 meters around the location, the numbers turn green, and they are permitted to 'pick up' the POI in the game. The zone of 30 meters around the location is a way of dealing with inaccuracies in creating zones in physical space by clicking on the map, potential obstacles in the physical space, and also the potential inaccuracies in GPS-data, which is contingent on several factors.

Figure 2. The mobile phone interface

SILO was designed for the creation of mobile location-based games, but not particularly for use in the classroom, nor for students to create games for each other. One relevant aspect of this is that the pages for creating a game are not private, and if they wanted the students would able to see the game that was created for them, before they were played it. This contradicts the geographical discovery involved with the game playing. The students were informed of this opportunity, and asked to not look at anyone else's games but their own, as it would make their gaming experience much less interesting. From our perspective, our interest was more in the creative process of writing the game, rather than on the game playing itself, so it was not too big an issue.

In addition, the students had access to a range of digital tools, available on their wifi-connected personal laptops, provided by the Fylkeskommune (the County Government) and in daily use in their regular schoolwork. These tools included office tools such as a text editor for temporarily working with the game text, and web browsers for searching for additional sources and material.

THE FIELD TRIAL

The students were informed about the project work two weeks in advance, and provided with some of the source material so that they could prepare for it, although this was not a requirement from the teachers perspective. The field trial took place in March 2011 and spanned six days and about 13 hours distributed over two weeks, during which time they created a game, played a game and created a digital media product. We provided 4 Nokia Navigator and 4 Nokia N80's phones for the field trial.

They were informed on how they would be evaluated beforehand. They would be evaluated on the basis of the game creation process, with emphasis on critical use of sources, types of sources, the level of creating a connection between historical events and how the city is today, how creatively they used the different locations provided in advanced, and on the group collaboration process. They would also be evaluated on the basis of the Digital Media Product that they created after having played a game, with emphasis on how the information that they discovered was processed and turned into a final product, and whether it was lifted from a reproduction to a more general discussion, in addition to use of historical terminology, discussion and the ability to make the history life-like.

Before the scenario started, the students were informed that participation was voluntary, that they were able to withdraw their consent to participate at any time without risk, also after completion of the scenario, and that use of the data material would be anonymised with regard to names. One group was informed that they would be videoed. While video is inherently non-anonymous in terms of the participants' visual and audible conduct being the focus of the study, a scaled consent form was used. Derry et al. (2010) distinguishes between *use* and *capture* permissions, when relying on video data in the learning sciences. The students were offered the opportunity to choose whether or not to participate at all (capture), and secondly to consent to a scaled degree of public use, ranging from presentation of sequences at conferences, use of screenshots in written papers, and use of the video

footage in closed data sessions with other researchers. For their participation, the students and teacher received a cinema ticket, and the students in the group that was being filmed, received a further two cinema tickets.

The Participants

The participants were a class of third-year (final year) students in an upper secondary school in the town centre of Bergen, Norway. A total of 27 students, aged 18-19, took part. The class was divided randomly in two groups, and each of the two groups was divided in four, resulting in 8 groups of 3 and 4 students, see table 1. Groups were also paired for exchanging games. For example, Group A was to create a game for group B and vice versa, group C was to create a game for group D and vice versa, and so on.

Group	Students	Group	Students
A	1, 2, 3	B	4, 5, 6, 7
C	8, 9, 10	D	11, 12, 13, 14
E	15, 16, 17	F	18, 19, 20, 21
G	22, 23, 24	H	25, 26, 27

Table 1. Organisation of class during scenario

Designing the Game

The game design and creation was carried out over a total of five two-hour (school hour) work sessions. Eight games were created. The groups chose to divide the locations between them, writing a couple of locations each, before they sat down and created a storyline behind all the locations. A variety of tools were used for this. The students used humour and ways of talking that were internal to the class, in several of the game storylines.

Playing the Game

The games were played successfully by four of the groups; the other four groups had phones that broke down before they got started. One of the groups chose to play the game made for them on paper instead.

Creating Media Products

They created a wide variety of media products after the game. Two groups made annotated picture collections using PowerPoint. One group made a poster, two groups made films, and two groups made information booklets. The final group made a presentation of their experiences of the game, and a presentation of their own game.

RESEARCH METHODS AND DESIGN

This research focus of this initial study is on the design and field trial of the learning scenario. In this paper we are interested in how students carried out the scenario and in gleaning some initial observations from an initial analysis of the data.

Data Material

The main data source for this study was video, but interviews, observation and collecting artefacts produced by the students were also carried out. A total of six sessions were filmed. These include the teacher's introduction, sessions which consisted of reading and re-writing source material tied to places, sessions where they created the game in the SILO interface, the session where they played their games, and the session where they created the media product. This resulted in a total of 12 hours and 45 minutes of video footage. When the students were working in groups the video footage was centered on one focus group, the same group for the duration of the scenario. The researchers were present during the filming, and the recorded material was digitalised and reviewed after each session. Each student group was interviewed face-to-face two days after the scenario was completed. A semi-structured interview guide was used, containing questions about the collaboration process, the creative aspects of the scenario, and how it contrasted to ordinary work forms in their school. The interviews with the groups, lasting from 20 to 30 minutes each, were recorded and transcribed.

The groups that were not being filmed were observed while they worked, and feild notes including which tools and sources they used, how they organised themselves collaboratively, and so on, were recorded. The teacher was also interviewed in a more lengthy session, lasting about one hour, which was also recorded and transcribed.

The student products that were collected included the games that they created and the media product that they created. The games were copied from the SILO system to a file in MS Word.

Data Analysis

The analysis of the data is in the early stages. However, based on initial reviews of the video footage, observations and interviews, a number of emerging observations have been made. These are presented in the following section.

FINDINGS AND OBSERVATIONS

We begin by presenting a chronological account of how the scenario unfolded, focusing on the content of the work in the different work sessions. Then, we present some initial observations based on the video footage, observations and interviews.

Session 1: The teacher began by explaining the contents and activities of the scenario to the students. She referred to it as 'their project'. Using a Smartboard to display a document she had prepared beforehand, she explained the topic, and that the perspective on the topic was local, that is, what happened in Bergen during WW2. She then explained the sources they could use, such as the school library, the public library, pictures video and text, in addition to the Internet and different texts that she had prepared for them. She then went through the more general goals for learning, and how they were to be evaluated and graded specifically on the work process with the game, and on the final media product. Then she explained that the scenario had to do with both historical events, and the geographical places at which they happened. Finally, she specified how the groups would be organised practically, that another group would use the historical information available in the game to create a media product after the gaming session, and that they in that way would be responsible for each other's learning. Finally, she laid out the time schedule and content for the different work sessions, and presented the basics of how SILO works. Following the introduction, the students arranged themselves in the specified groups and started working on the games.

Game Creation, sessions 2, 3 and 4: The focus group, working on a laptop each, start off by discussing the different locations that they have been assigned, and how to search for information. Initially, this is carried out as a group discussion, with the members searching for information on their laptops indvidually, and then sharing the information, and discussing it with earch others. In Session 2, they start off by visiting the public library of Bergen, to find more information. The focus group, and most of the other groups, relied most heavily on books as their main source of background information, citing the need for specialised information as the reason for this. For the remainder of Session 2, the groups largely work in silence. Session 3 begins with us explaining how to use SILO. This session also contains a lot of working in silence, with the occasional discussion of various aspects of the locations in the game. In the focus group, the actual entering of the storyline into the SILO system was carried out by one of the students, based on the document that they prepared in Word. This was contrary to how most of the other groups carried out this particular aspect of the game creation.

Playing the game / Telephone failure, Session 5: On the day of the game, four of the eight mobile phones broke down before the groups got started. The four phones that worked fine were Nokia Navigators, and the four that did not were Nokia N80's. They had seemingly worked fine the day before, when the games were installed. The solution for this was that two of the four groups without a working phone got printouts of the game content, and played it by reading the information that they would have gotten on the phone when they would have gotten it, to find the places they were supposed to find while playing the game. Two of the groups visited two museums, one of which they would have encountered in the game, and an additional museum with similar kinds of displays. While they experienced a highly reduced gaming experience, they were still able to visit the places that they needed to create their media items about the experience. The focus group, playing with a phone that worked, display similar ways of accomplishing game play described in Wake, Guribye and Wasson (in press). For example, navigation is socially accomplished by visibly demonstrating the act of navigation through bodily postures, and involves a lot of reading out loud feedback from the phone. Previous studies of game play have also revealed that the competetive element of the game, winning by completing it the fastest, have caused some participants to hurry through the game in order to win, and not pay so much attention to observing various aspects of the geography. The decision to plan for the groups to capture information in some form at the different locations seems to have been a success in that respect - they discuss much more of the meaning of the location than what has been seen in previous studies of SILO.

Creating the Media Product, sessions 6 and 7: The focus group decided, whilst arriving at the first location during gameplay, that they would create a poster on paper, using pictures that they took while on site. The group photographed themselves next to the different locations that they visited, and used these in the poster, along with maps and other pictures they were able to find. They first created a mock-up poster, also on paper, before they created a poster that was more visually polished.

Initial Observations

After an initial review of the data, a couple of observations have emerged. One has to do with the collaboration process, another with the choice and range of digital tools that the students used. Another has to do with emotion and engagement with working with and playing the games.

Individual & Collaborative: The students were free to organise their work as they saw fit. Thus it was interesting that all the groups organised themselves such that each student took the responsibility for two or three of the historical locations/themes. This entailed gathering relevant background material, sorting the information and writing up what they believed was relevant. After this individual work, they came back together as a group, and worked on creating a storyline threading together the locations, making it into a coherent narrative. This also allowed the students to see what the other members of the group had written about their theme/location. The interviews and observation reveal that this way of working was the same for all the groups.

Digital Tools: The students used a surprisingly wide range of digital tools in order to construct their games, many of which we did not plan for in the scenario design. For writing of historical information related to each theme most of the groups relied on Microsoft Word, although one of the groups used the web-based typewith.me. Another of the groups, a group of three where two of the members were absent during several work sessions, because of illness, used Facebook to create a password-protected page where they stored the documents that they were working on, so that all the work would be available for each of the group members. In the creation of the games, the students also used Google Streetview for matching the map in SILO (openstreetmap.org) with images of the places in question. In particular they used Google Streetview to check for physical restrictions around each location, to avoid setting the location behind a fence or on top of a building, in addition to the map in SILO. The groups that chose to make a movie out of their game experience used Windows Moviemaker, in addition to a movie converter tool that they found on the Internet. Making the choice and finding the available digital tools for the many different purposes, other than the SILO system itself, was largely carried out on the students' own initiative.

During the playing of the game, they used a range of cameras, on their private mobile phones and specific purpose cameras that they borrowed from the school. When re-composing their gaming experience into a video, they used Microsoft Moviemaker. The class also used a Learning Management System (LMS) for communicating out of class, and keeping relevant information.

Motivation: It rather quickly became apparent that working with creating games had a high motivational effect, in particular oriented towards the competitive element, an aspect that the teacher highlighted in the interview. The teacher reported an unusual eagerness in working with the games, and used the unusual silence of the class, and their working in the breaks as examples. The video footage supports this observation; there are long stretches where only whispering can be heard. She speculated that it was the competitive elements of the gaming that sparked this engagement. One of the groups was visibly angered when returning from playing the game (the teacher had to provide them with chocolate for them to calm down), and the reason was that they believed that the group that created a game for them, made it rather difficult to play on purpose. The interviews also reveal that some of the students called each other up whilst playing, to avoid using hints available in the game, decreasing their chances of winning (the team that completes the game in the shortest time, using fewest hints, wins the game), requests that reportedly were turned down.

Variety of Media Products: Two of the groups chose to make movies out of their experiences, retelling the story content in a new format. One of these movies contained footage of the students acting and re-living the historical themes and events at the different locations. One group chose to do a poster (on paper), and two groups made PowerPoint slides with text and pictures taken whilst playing the game. One group chose to do a presentation of their own game, and their experiences on the field day. This group had a phone that did not work.

CONCLUSIONS

In this paper we have presented a learning scenario that has been designed to help students learn about local history. Students learn about selected local history events by creating a location-based mobile game to be played by another group. In addition, they learn about complementary local history events by playing the game created by another group. Finally, they reflect on what they have learned by playing the game through the creation of a digital media product.

Our field trial has shown that the students and the teacher were very enthusiastic about this approach to learning local history. The students worked both individually and collaboratively. They were creative in their use of digital technology to carry out the activities and they produced a wide variety of media products.

Our subsequent analysis will examine the data more carefully. Here, we will look at how the students are practically accomplishing the creation of a game through their interaction.

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Structuring mobile and contextual learning

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ABSTRACT

Many attempts have been made to define the nature and focus of mobile learning. This study is based on a previous expert study that intends to structure the research problems that are underlying the domain of mobile and contextual learning. The previous study identified three core clusters of research problems in our domain. This paper analyses the research problems underpinning the previously identified clusters and identifies research topics within these clusters. This supports a more structured understanding of research problems that are specific to mobile and contextual learning and how these problems are related.

INTRODUCTION

Mobile learning is a research topic that connects the vibrant fields of mobile and ubiquitous technologies with education and learning. This topic strives for developing the educational paradigms and technologies for the mobile information societies. Several attempts have been made to define the nature and focus of mobile and contextual learning research (Sharples, 2006; Traxler, 2009). The perspectives taken are either techno-centric, consider the mobility of the learners, or rest upon the anytime/anywhere paradigm for content consumption (Winters, 2006; Taylor, 2006). Especially the techno-centric perspective is highly controversial because the underlying development of mobile technologies is continuously progressing. This makes the attempted definitions highly unstable (Traxler, 2009).

Traxler's (2009) suggestion to emphasize the role of education and learning of mobile learning motivated the present study. This has resulted in an empirical expert study that has focused on the structure of the underlying research problems of mobile learning (Börner, et al. 2010). Although the previous study identified three primary research clusters that are specific to mobile learning: "access to learning", "contextual learning", and "learning across contexts". However, that study did not analyse and compare their internal logic. This paper further analyses the results of this expert study in order to identify overarching research questions that are specific to mobile and contextual learning. Consequently, the present paper focuses on the research problems within the previously identified clusters. It analyses the relation and perceived value of research problems in relation to their clusters. This leads to insights to the kind of overarching problems that are tackled by mobile and contextual learning and relates them to concrete research challenges.

METHOD

In order to identify the underpinning research problems of mobile and contextual learning, the present study implements Trochim's (1989a, b) concept mapping approach. The underlying method has been applied in several studies (Stoyanov & Kirschner 2004; Wopereis, Kirschner, Paas, Stoyanov & Hendriks, 2005). It provides an approach to structured and participative conceptualization that identifies clusters of ideas and opinions empirically. The source data is collected from key stakeholders by brainstorming and categorizing ideas. The resulting data is then analysed via multidimensional scaling (Kruskal & Wish, 1978; Davison, 1983) and hierarchical cluster analysis (Anderberg, 1973; Everitt, 1980). The result is a set of visual maps representing the generated ideas and opinions as well as emerging clusters and thus important domain concepts. The method has three phases to collect the data that are described below.

The initial phase of the method has three objectives: defining an initial focus or trigger statement for stimulating the generation of ideas and opinions, selecting key dimensions for rating the generated statements, and selecting the participants. Derived from the first research question the following trigger statement was: *"The educational problem that mobile learning tries to solve is…"*. Based on the experiences of previous studies (Stoyanov &

Kirschner 2004; Wopereis, Kirschner, Paas, Stoyanov & Hendriks, 2005), *importance* and *feasibility* were selected as respective key dimensions. These qualitative dimensions emphasize different aspects of the practices within the domain. During data inquiry the participants have to rate each statement on the two dimensions on a 5-point Likert-scale. For importance the value 1 means the statement described a less important educational problem that mobile learning is trying to solve and 5 means the statement described a highly important educational problem. Similarly, for feasibility the value 1 means solving the described educational problem through mobile learning is not feasible and 5 means that the problem could be solved through mobile learning.

The participants were selected from the member list of the International Association for Mobile Learning (IAMLearn, 2009). 32 international acknowledged experts have been invited to participate in the study. The invitees represented different stakeholder groups within the mobile learning domain, ranging from industry via research to educational practitioners. 20 of the invited experts accepted the invitation to participate in the study.

Given to the international distribution of the participants, the communication as well as the data collection has been conducted entirely online via e-mail. The data collection procedure has been conducted in the following two phases: (a) generating idea and opinion statements and (b) structuring the generated statements. Due to the characteristics of the method, the participants were actively involved in both steps of the data collection process. In order to collect as much information as possible from the participants while reducing the communication overhead, the categorization and the rating of the statements has been combined in the structuring phase.

In the second phase the participants were instructed to identify educational problems as short bullet point statements in relation to the trigger statement. The participants were free to generate as many statements as they liked. Furthermore, the participants were requested to describe exactly one educational problem per statement and if possible limit the generation process to 10 minutes.

In the third phase all participants were asked to structure the collected problem statements. The participants were contacted regardless of their participation in the previous phase. The structuring of the statements involved two independent steps: grouping the statements based on their perceived similarity in meaning and the rating of the statements. The participants were asked to perform this task within two weeks. 9 experts participated in the second phase, grouping and rating the statements that were previously generated.

For the first step the participants were asked to group the statements based on their similarity in meaning by copying the statements from one document containing all statements into a second document containing a prepared form with empty group containers. The participants were informed that they should place each statement only into a single group, while each group should contain statements that were similar in meaning. The instructions emphasized that the similarity must focus only on the content of the statement. If a statement in the participants' opinion was unrelated to the other statements or stood alone as a unique idea, they were asked to put this statement in its own group. Arbitrary groups such as "misc" or "junk" groups were explicitly forbidden. Again the experts were free to create as many groups as they liked, although it was suggested to them that 10 to 20 groups should work out well in most cases. After grouping the statements the experts were asked to rate each statement in the third document.

RESULTS

During the second phase, 11 experts generated 70 problem statements. For preparing the third phase the statements were restructured into grammatically correct sentences and simultaneously revised for spelling mistakes whenever this was necessary. Furthermore, statements that referred to several ideas were split so the resulting statements included only a single idea. Finally, all the statements were compared to eliminate obvious duplicates. The result of this data cleaning was a list of 82 unique statements. During the third phase, the experts created 111 groups in total with an average of 12 groups per expert.

The data analysis techniques described by Trochim (1989a) were used to map the problem statements, as well as to identify and to label the problem clusters. The clusters represent overarching domain concepts related to the educational problems addressed by mobile learning. Figure 1 shows the problem cluster map of the presented study. The distance between the points in Figure 1 indicates how often two statements were grouped together: the closer two points are, the more often the experts sorted them into the same groups. The following 7 problem clusters cover all 82 statements.

(1) Access to learning: The cluster covers 15 statements that mainly relate to the challenges of enabling learning in a mobile society. This includes educational problems that are related to flexible learning, including just-in-time learning, equal access to education and learning, as well as location-based learning. The cluster also covers remote learning and accessibility aspects.

(2) Limitations for learning: 9 statements belong to this cluster. The statements cover challenges related to organizational and educational problems of educational institutions that result from different perceptions of the knowledge society in general and mobile technologies specifically among educators and learners. This also includes the problems of using of mobile technologies in formal learning scenarios.

(3) Contextual learning: The cluster includes 18 statements that highlight the relation between learning and the context in which the learning takes place. The cluster covers individual aspects of situated learning, learning in context, and learning across contexts. Furthermore environmental aspects are included, such as making use of environmental affordances and a stronger interaction with the environment where the learning takes place.

(4) Collaboration: 5 statements are included in the cluster. The statements cover challenges that relate to collaboration, sharing learning resources, and problems related to social interaction, such as difficulties of building a community during learning.

(5) Personalization: The cluster includes 8 statements. The statements range from educational problems with self-directed learning to mass-customisation of learning and reflect the potential of mobile learning to support personal learning processes and engage learners.

(6) Learning across contexts: The 14 statements included in this cluster deal with problems related to current educational practices. The cluster is strongly related to the contextual learning cluster, but focuses more on how mobile learning can support the transition between contexts.

(7) Technology and technology adoption: The cluster covers 13 statements. These statements address challenges related to the technological characteristics of mobile devices and factors of their adoption, including cost effectiveness, usability, and user-acceptance.
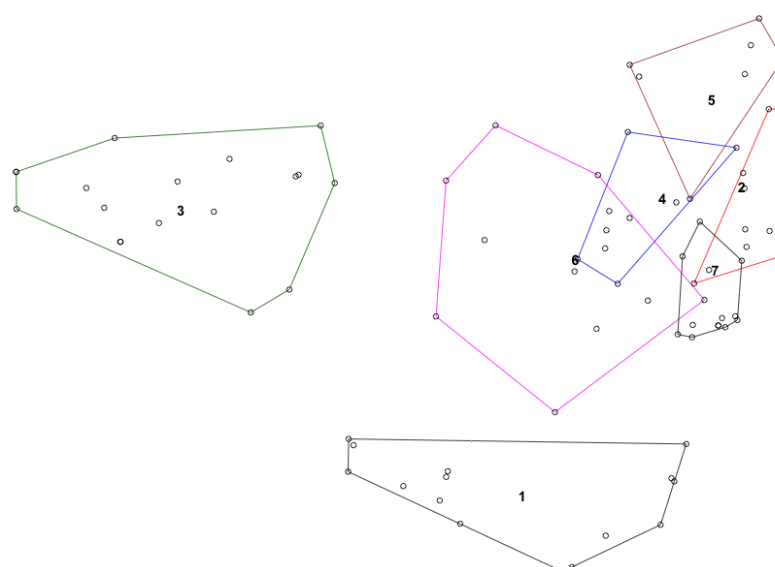
Figure 1 - Problem cluster map

The detailed analysis of the average rating of the problem statements indicates the experts' opinion about which statements refer to important and feasible educational problems related to mobile learning. Furthermore, this analysis allows estimating the relevance of the 7 problem clusters as domain concepts for mobile and contextual learning research.

Starting with the problem statement emphasis, a statement was considered as important or feasible if its mean rating was at least 3.5 on the 5-point Likert-scale rating. An average rating of 3.5 indicates that the experts rated the statement mostly as important or feasible. By taking both rating key dimensions into account the statements were mapped into four quadrants, which is presented in Figure 2.

The first quadrant contains those statements that are relevant on both dimensions, given a high average rating on importance and feasibility. These statements refer to the most relevant educational problems addressed by mobile learning. The second quadrant contains statements with a high average rating on importance but low average rating on feasibility. The statements in this quadrant can be considered to refer to important educational problems addressed by mobile and contextual learning, while sufficient solutions might go beyond the scope of this field. The third quadrant contains statements with low average ratings on both dimensions. These statements are considered to refer to educational problems that are not specifically related to mobile and contextual learning in the experts' opinion. The fourth quadrant contains statements with a high average rating on feasibility but low

average rating on importance. The items in this quadrant refer to side problem to which the research field can offer solutions.

By comparing the results from the cluster analysis and the ratings, it shows that the majority of the statements in the first quadrant belong to the clusters "access to learning" (cluster 1) and "contextual learning" (cluster 3). The cluster "learning across contexts" (cluster 6) contains about the same amount of statements in the first and third quadrant, while the other clusters primarily contain statements that are located in the third quadrant. Moreover, the mean rating of all statements in these three clusters is greater than 3.5 on at least one scale. Consequently, the clusters "access to learning", "contextual learning", and "learning across contexts" can be considered as the primary scope of research problems that are characteristic for mobile learning. The following analysis concentrates on the specific characteristics of these clusters.
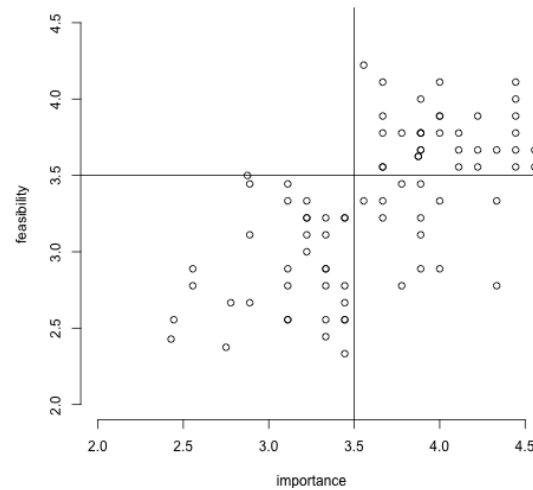
Figure 2 - Statement rating map including all statements

Cluster 1: Access to Learning

The access to learning cluster refers to a set of research problems that address the access to learning opportunities and educational resources. These research problems emphasize the "mobility of learners" (statement 25) as a central aspect for enabling learning. This specific area includes two themes. The first theme refers to challenges related to e-inclusion. The second theme in this cluster is best described by statement 17: "Access to learning resources and learning opportunities without restrictions of location, time and cumbersome equipment or facilities". A complete list of statements of this cluster is provided in Table 1.

Cluster	Mean	
Statement	Importance	Feasibility
Cluster "Access to learning"	*4.03*	*3.59*
17 Access to learning resources and learning opportunities without the restrictions of location, time and cumbersome equipment or facilities.	4.44	4.00
59 Access to information when and where it is required, through 'just in time' browsing of relevant information, and information push to support learning in context.	4.44	3.89
41 Easing access to educational opportunities.	4.56	3.67
25 Mobility of the learner.	4.00	4.11
79 Including learners from rural areas.	4.22	3.89
61 Accessibility of information in relevant everyday life and work situations.	4.33	3.67
9 Learning at anytime.	3.98	4.00
80 Developing third world countries' education.	4.11	3.78
8 Learning from any location.	3.89	3.78
11 Just in time information for immediate application.	4.11	3.56
1 Limited access by some learners in remote locations.	3.67	3.89
51 Enable learners in classroom settings to have equal access to rich resources and computational tools to support curriculum learning.	3.89	3.22
78 Including learners with disabilities.	4.33	2.78
4 Nomads who move from one location to the next while learning.	3.22	3.22
45 Inequality of access to computers, learning resources and teachers.	3.33	2.44

Table 1: Statements and ratings of the cluster "access to learning"

The two themes are also visible in the problem cluster map for the related statements as shown in Figure 3. On the right-hand side of the cluster area are the statements about e-inclusion and on the left-hand side are those statements regarding flexible learning. In this cluster the mobility itself is the central aspect that influences the access to learning. Although the statements related to the two topics appear in different spatial areas in the cluster map, the cluster remains stable for different "cuts" of the hierarchical cluster tree (for 2 < k < 10). This indicates that the statements form a distinct class of research challenges rather then merging two sub-clusters.
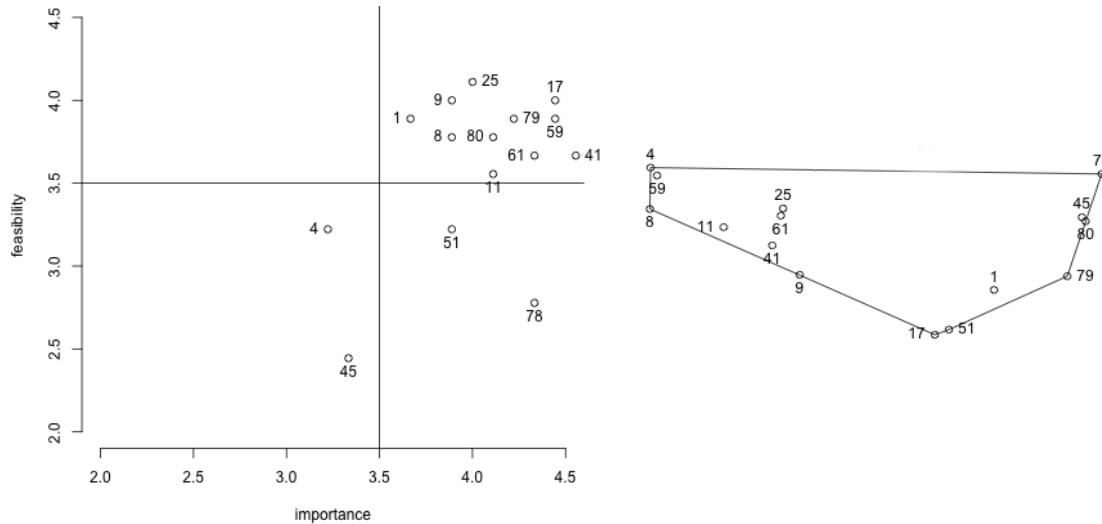
Figure 3: Access to learning: rating of statements (left) and statement relatedness (right)

Cluster 3: Contextual Learning

The contextual learning cluster integrates research challenges that emphasize the relation between learning and the setting in which it is situated. The cluster includes location-based learning problems (statement 39, 58, 29, 57, 55, 56, and 70), authentic learning (statement 3, 12, 16, 30, 33, and 50), and the relations between contexts (statement 53, 74, and 60). This cluster forms a distinct field of statements that appears isolated from other statements that were mentioned. Figure 4 shows the distribution of the statements on the cluster map as well as their average rating.

Cluster	Mean	
Statement	Importance	Feasibility
Cluster "Contextual learning"	*3.92*	*3.60*
53 Connect learning across contexts, including between formal and informal settings.	4.44	3.78
16 Ability to discover and experiment in own context.	4.44	3.67
30 The provision of access to knowledge in the context in which it is applied.	4.56	3.56
33 Taking education out of classroom settings into meaningful settings.	4.00	3.89
39 Interacting with your environment to achieve new knowledge from it.	4.22	3.67
50 Under-utilization of potentially rich learning resources in heritage sites, art collections and all sorts of other interesting places.	3.56	4.22
73 Learning in context.	4.00	3.78
74 Learning across contexts.	4.22	3.56
58 Using technology to probe or to enrich understanding of the natural environment, and annotating the environment for the benefit of visitors.	3.67	4.11
29 The design of augmented contexts for development problem to enable collaborative problem solving where learners generate their own 'temporal context for development'.	3.89	3.78
12 Learners cannot learn in context.	3.88	3.63
57 Making use of affordances of locations to support learning.	3.88	3.63
55 Enable enquiry-based learning in novel locations, through novel locations, and about novel locations.	3.89	3.44
63 Contextualization of e-learning.	3.67	3.56
56 Making use of space and environment as a backdrop for engaged spatial learning.	3.67	3.22
70 The worthwhileness of location-based and contextual mobile learning.	3.56	3.33
60 Enable learning through distributed conversation across contexts.	3.78	2.78
3 Insufficient real life experience in the learning process.	3.22	3.22

Table 2: Statements and ratings of the cluster "contextual learning"

The statements in this cluster have in common that they refer to abstract research problems. The statements "learning in context" (statement 73), "contextualization of e-learning" (statement 63), or "Connect learning across contexts, including between formal and informal settings" (statement 53) are typical for this cluster. A complete overview of the statements is provided in Table 2.

Figure 4: Contextual learning: rating of statements (left) and statement relatedness (right)

Cluster 6: Learning across contexts

Cluster 6 combines statements that focus on the transition between and the integration of contexts, particular with respect to the connection of classroom-based with informal learning experiences. Within this overarching scope of the cluster three topics are present that are also reflected by the highest rated statements. The first topic addresses the arrangement and orchestration of learning opportunities (statement 62, 37, 52, and 18), the second topic covers the transition between (spatial) contexts (statement 28 and 54), and the third topic refers to the participation and collaboration across contexts (statement 20, 49, and 52). A detailed overview over this cluster's statements and their ratings is provided in Table 3.

Most statements in this cluster highlight the activity facet of mobility as a relevant factor for learning. Furthermore, the entire cluster appears to be more related to educational applications and practice of mobile learning, because it contains more concrete research challenges than the other two clusters. This is also reflected by the closer relation of this cluster to the technical aspects of mobile learning (cluster 7), collaboration (cluster 4), and the limitation of learning (cluster 2).

The problem cluster map indicates a close relation to the "collaboration" cluster (cluster 4) as the statements 10 and 19 of cluster 4 appear deep in the area of the "learning across contexts" cluster (Figure 5). Statement 10 relates loosely to the participation topic without explicitly referring to specific contexts. Statement 19 is related to the arrangement of learning opportunities, but emphasizes context independent aspects.
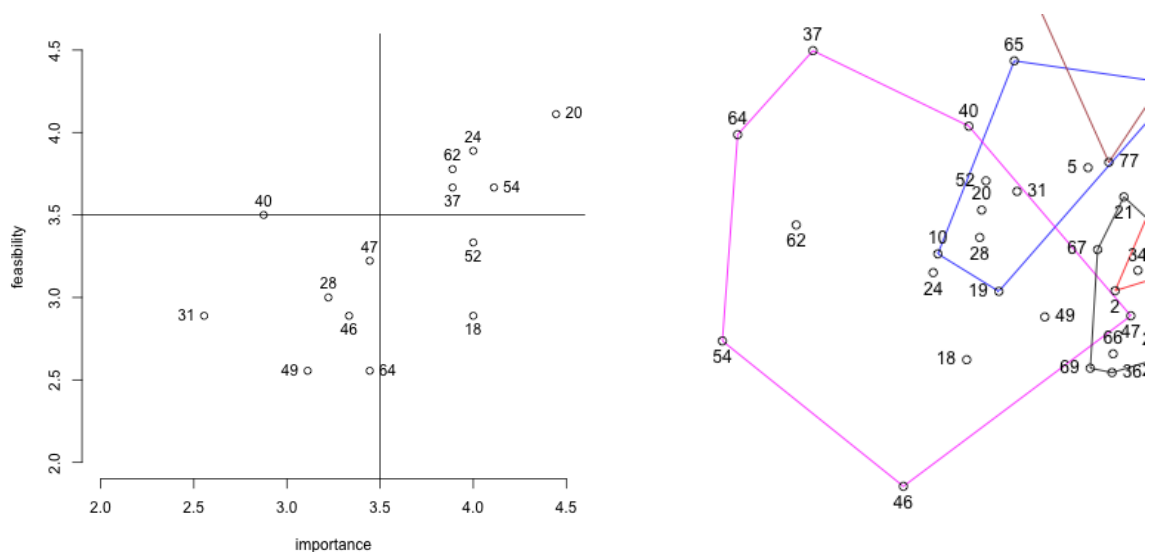
Figure 5: Learning across contexts: rating of statements (left) and statement relatedness (right)

| Cluster | Mean | |
Statement	Importance	Feasibility
Cluster "Learning across contexts"	*W3s*	*3.60*
20 Actively participate in learning activities outside of formal educational settings and facilities.	4.44	4.11
24 Flexibility for the learner.	4.00	3.89
54 Maintaining continuity of learning across settings, such as between classrooms and museums on school field trips.	4.11	3.67
62 Documenting real time experiences of learners.	3.89	3.78
37 Design suitable activities for the mobile learners.	3.89	3.67
52 Orchestrate new forms of classroom pedagogy that require coordination of individual, small group and whole class activity.	4.00	3.33
18 Provision of opportunities to contribute to the development/production of learning resources and course content without the restrictions of location, time and cumbersome equipment or facilities.	4.00	2.89
47 Blinkered, old-fashioned views about education stopping when working lives begin.	3.44	3.22
40 Anything is a potential learning scenario.	2.88	3.50
28 Outside in, inside out problem, where cultural practices involving new digital media can be brought into formal learning institution, get enhanced inside the institution and in turn feedback into the digital world at large.	3.22	3.00
46 Pressured, busy, fragmented, mobile lives leaving little quality time for conventional, place-and-time-dependent education.	3.33	2.89
64 Transfer of training.	3.44	2.56
49 Gaps (time lags) between traditionally scheduled learning sessions, limiting achievement, teamwork and collaboration.	3.11	2.56
31 Refreshing the image and practice of institutional e-learning.	2.56	2.89

Table 3: Statements and ratings of the cluster "learning across contexts"

DISCUSSION

The analysis of the experts' statements revealed 7 research problem clusters to which research on mobile and contextual learning contributes. 3 clusters appear specific to the field, because the experts who participated in the study rated the statements covered by these clusters primarily as highly relevant on the two rating dimensions "importance" and "feasibility" identified these clusters. For the clusters "access to learning" and "contextual learning" the mean scores of both dimensions were above 3.5. For the cluster "learning across contexts" the mean score on the importance scale was above the threshold. The other 4 clusters had mean scores below 3.5 for both rating scales.

The analysis of the statements in the clusters indicated that each cluster relates to one overarching challenge for learning. Related to these research challenges recurring topics of the statements within the clusters were identified. These topics allow research to focus on specific research questions within the scope of a challenge. Table 4 lists the research challenges and the related topics.

The distribution of the statements within each cluster indicates that the related topics are specific to the cluster and do not represent sub clusters. Only for cluster 1 ("access to learning") the statements related to the included topics appear in different spatial areas in the cluster map. However, this cluster remains stable for different "cuts" of the hierarchical cluster tree.

Learner mobility (Cluster "Access to learning")
E-inclusion
Flexible learning
Influence of context on learning (Cluster "Contextual learning")
Location-based learning
Authentic learning
Relations between contexts
Transitions between contexts (Cluster "Learning across contexts")
Arrangement and orchestration of learning opportunities
Transition between contexts
Participation and collaboration across contexts

Table 4: Research challenges and related topics

When comparing the statements of the clusters a remarkable difference was found for the highly statements of cluster 3 "Contextual learning" and cluster 6 "Learning across contexts". The highly rated statements of cluster 3 are relatively vague (Table 2), while the highly rated statements in cluster 6 refer to more concrete educational and learning problems than similar statements in other clusters (Table 3). This suggests that the topics in cluster 3 are not as well understood as for other clusters and require more fundamental research. Similarly, the topics of cluster 6 appear to be well enough understood for addressing applied research problems.

CONCLUSIONS

This paper analysed the results from an expert study for structuring the domain of mobile and contextual learning. This study has identified 7 clusters of research areas that are relevant to this domain, of which 3 clusters appear to be specific to mobile and contextual learning. Within these primary research clusters 8 research topics were identified. Together with the clusters, the topics can get used to structure the core research challenges of mobile and contextual learning.

The identified clusters provide a coherent perspective on mobile and contextual learning challenges beyond the scope of technology applications. Among the most relevant clusters, most of the prominent problem statements were relatively vague. This suggests that this field of technology-enhanced learning is still emerging and many important facets require development for defining more concrete perspectives on the identified research challenges.

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Mobile Learning and the distance learner: Implications for practice

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ABSTRACT

The increasing ubiquity of mobile devices in the developed world is providing opportunities for these devices to support learning and teaching activities. Mobile learning is seen as offering many advantages to learners, not least being the ability for anywhere, anytime learning. This particularly applies to distance learners who are recognised for their preference to be able to learn in times and places that suit their individual needs.

A recent qualitative study into distance students' experience with information communication technology (ICT) suggests that many distance learners are essentially also mobile learners and that mobile devices are becoming increasingly important in supporting these students in their learning. However, the study also identified that higher education institutions may be largely unprepared for the impact of mobile devices or that their students may wish to use them. This paper discusses mobility and mobile learning and what this means specifically to distance learners. It reports on the findings of a study of twelve distance learners in relation to mobile learning and discusses the implications this has for policy and practice within higher education institutions.

Author Keywords

Mobility, mobile learning, distance learning

INTRODUCTION

The rapid growth in the ownership of mobile devices, particularly mobile phones, over the last decade has resulted in almost ubiquitous ownership in Australia in particular and in the developed world in general.

In western higher education environments, few teachers or their students are without a mobile phone or laptop at their disposal (Andrews, Tynan & Stewart, in press).

The widespread availability of these devices has created opportunities for mobile learning that were previously unachievable (Andrews, Tynan & Stewart, in press) with much discussion around the ability to support anywhere anytime learning (Ramaprasad, 2009) and the wide variety of educational activities that can be enabled by mobile learning (Stevens & Kitchenham, 2011). This paper outlines a recent study that explored the distance learner's experience with ICTs for teaching and learning. Among other issues, the study sought to identify the ways in which distance learners' are using both their own and institutionally provided technologies to support their learning and as well as their preferences for how they might want to use these technologies for their teaching and learning activities. This paper reports on those findings relevant to mobility and is but one aspect of the study. The study also investigated learning spaces and social networking which are reported elsewhere.

DISTANCE EDUCATION AND DISTANCE LEARNERS

Growth in distance learning has been rapid in the last two decades with increasing numbers of students opting to learn in this way (Andrews, Tynan & Stewart, in press). Definitions of distance education can vary considerably and are further confused by interchangeable use of terms such as online learning, elearning and distance learning (Guri-Reozenblit , 2009). For the purposes of this paper:

Distance education, also variously referred to as distance learning, e-learning, online learning, online education or distributed learning (Guri-Rozenblit, 2009), can be simply defined as a system of education

delivery in which the majority of learning takes place with the learner and the teacher separated by space and/or time, the gap between the two being bridged by technology (Andrews, in press).

Distance learners can be considered those who complete the majority of their study off-campus and generally experiencing little or no face-to-face interaction with other students or with teachers (Allen & Seaman, 2008).

MOBILE LEARNING

As Traxler, (2007) points out, defining mobile learning is difficult as what constitutes mobile learning is still an emerging concept. However, he does suggest that identifying what makes mobile learning different from other forms of learning would be a useful starting point. Consequently he proposes an understanding of mobile learning

...in terms of the learners experiences and an emphasis on 'ownership' 'informality' mobility and context that will always be inaccessible to conventional 'tethered' elearning (Traxler, 2007).

Understandings of mobile learning are strongly influenced by the concept of mobility, which is considered to be one of its defining characteristics. The description of mobile learning provided by Kozalka and Ntloedibe-Kuswani (2010) also considers mobility to be an integral aspect:

Learning where instructions and support mechanisms are facilitated through m-technologies for learners who are mobile themselves. Instructional activities are not within a set place. Rather learners are engaged, often synchronously with others and learning resources, while outside the borders of a formal classroom (p. 142).
In relation to learning, this broadening beyond physical and time related boundaries through mobility enables teaching and learning activities to expand into a limitless range of spaces, places and contexts, further differentiating it from other forms of learning (Traxler, 2007). As Kozalka and Ntloedibe-Kuswani (2010) point out, the availability of mobile technology means that in many cases "learners have turned into nomads" (p. 140) and are increasingly seeking to use the affordances of mobile technologies to support their learning (Van Der Werf & Sabatier, 2009).

Further to this Traxler (2007) also suggests that mobile learning offers unique opportunities to personalise learning for individuals which also further differentiates it from other forms of learning:

We would argue that mobile learning offers a perspective that differs dramatically from personalised conventional e-Learning in that it supports learning that recognises the context and history of each individual learner and delivers learning to the learner when and where they want it.

MOBILE LEARNING FOR DISTANCE LEARNERS

Studies in the area of mobile learning (mLearning) and distance learning cover a variety of areas and intersect in part. There is also considerable rhetoric in the literature and more broadly in relation to the benefits of mobile learning for distance students. Yousef (2007) investigated the effectiveness of mobile learning and distance education in the Turkish context and found that amongst other things the use of mobile learning increased distance students' ability to access anywhere anytime learning. Rekkedal (2002a, 2002b) also found that the main advantages of mLearning for distance students was in increasing their flexibility for the ways in which they were able to learn. In their synthesis of studies into mLearning and distance learning Kozalka and Ntloedibe-Kuswani (2010) found that common amongst these studies "was an effort to further engage learners deeply with content" (p. 149).

However in spite of the opportunities, creating whole-scale approaches to integrating mobile learning into distance education programs faces considerable challenges. Corbeil and Valdes-Corbeil (2007) undertook an investigation into the readiness or otherwise of students and teachers for mobile and distance learning. This study showed that while most students and staff owned mobile devices, staff perceived that a considerable amount of work and time would be required to convert existing distance education materials into materials suitable for mobile learning. This view is further supported by Traxler's (2007) observations:

Mobile education, however innovative, technically feasible, and pedagogically sound, may have no chance of sustained, wide-scale institutional deployment in higher education in the foreseeable future, at a distance or on site. This is because of the strategic factors at work within educational institutions and providers. These strategic factors are different from those of technology and pedagogy. They are the context and the environment for the technical and the pedagogic aspects. They include resources (that is, finance and money but also human resources, physical estates, institutional reputation, intellectual property, and expertise) and culture (that is, institutions as social organisations, their practices, values and procedures, but also the expectations and standards of their staff, students and their wider communities, including employers and professional bodies).

METHODOLOGY

The study reported here has a focus on one sub-group of learners which are those who study at a distance.The study took a qualitative approach to exploring the student experience, an approach recommended by Sharpe et al. (2005) in undertaking studies that intend to explore not just students' experiences of learning, but their views and feelings about those experiences.   As in other similar studies (Conole, 2008; Mayes, 2006) this study took a phenomenological approach. This approach allows a focus on people (Bresler, 2006) and on investigating the 'lived experience' in relation to the phenomena being explored (Starks & Brown-Trinidad, 2007), and consequently employ student centred approaches to data collection (Mayes, 2006).

The overarching question for this study was 'What are the experiences of distance learners' use of Information and Communication Technologies (ICTs) for teaching and learning?' The study particularly sought to understand both how students were using both institutional and personal technologies and bow they would prefer to use these technologies to support their learning.

Methods

In keeping with a phenomenological approach, both student centred and phenomenological approaches to data collection methods had a strong focus on diaries (Jefferies, 2009). The main data collection methods were the Day Experience Method (DEM), Charting the Week's Activities (CWA) and focus group discussions. Students were also asked to provide photos of their learning spaces. To ensure accuracy of the data the completed student voice studies were sent to the students for verification, before finalisation and publication of the studies. In all cases the studies required very minor editorial changes, highlighting this approach as a valid means of capturing the students views in relation to their learning experience.

The Day Experience Method (DEM) was developed by Riddle and Arnold (2007) drawing on the Day Reconstruction Method (DRM) and the Experience Sampling Method (ESM) (Hektner, et al., 2007). The DEM requires participants to allocate a 24 hour period to respond to irregular SMS prompts and record their answers to a series of questions. For this study the method was adapted slightly and students were required to be available for an 18 hour period. Prompts were sent by SMS to participants' mobile phones at irregular periods throughout this time and on receiving the prompts students were asked to record their responses using either a digital (audio/video) diaries or text based diaries. The questions students were required to respond to related to the time, the nature of their activities and the ICT resources they were utilizing.

As it was recognized that distance students may not necessarily have a typical learning day or that these days might vary considerably it was felt that the DEM would not adequately capture the patterns of learning with ICTs that the students commonly engaged in. Consequently, drawing on the Day Reconstruction Method (DRM) (Hektner et al., 2007) the researcher developed another technique called Charting the Week's Activities (CWA) to capture the range of student learning activities over a period of a week. Students were asked to provide a daily summary of their work, learning, social and family activities for each day, and the technologies, other resources and spaces they used for teaching and learning activities. Again, participants were encouraged to provide this information in a digital dairy, but were given the option of using print if preferred.

Additionally the students were asked to take photos of their learning space or spaces and send them to the researcher. These were later used for discussion in the focus group conducted online using Skype. Photos were distributed amongst the focus group participants (3-4 per group) by email and used as prompts to discuss both spaces they used for learning and their wider use of ICTs within these spaces.

While the DEM and CWA methods provide an indepth understanding of the student's view and feelings about the phenomena being investigated, a disadvantage of such approaches is that participants can find the data collection processes onerous and fail to provide all the data required (Ganeson & Erich, 2010). For this study students were diligent in meeting the requirements of the data collection process.

Participants

The participants in the study consisted of students enrolled in postgraduate and undergraduate distance programs who were purposively selected to represent a range of distance learning programs and experiences. After obtaining the appropriate ethical clearance for the project a letter outlining the requirements of the study and requesting participation from a range of distance learning experiences was sent to all distance students via the University's student support Facebook page. Students responded directly to the researcher by email. Twelve students were identified as representing a range of different distance learning experiences including:
- Full time workers, part time learners

- Full time learners
- People making significant contributions to their communities along with studying
- Undergraduates
- Postgraduates
- People with health issues

During the information session via Skype, dates were arranged for completing the data collection requirements for the DEM and CWA activities and the details of the activities were explained. For their DEM day participants were asked to select a day that represented a typical learning day.

RESULTS AND DISCUSSION

All of the students in this study demonstrated highly individual approaches to the way they used technologies for learning (Kirkwood, 2000), however, there were also significant commonalities. For 11 of the 12 students in this study mobile learning was an essential aspect of their learning experience. These participants identified themselves as both distance and mobile learners. The sentiment expressed below was common across these participants:

I consider myself a mobile learner because I study on the go all the time. (Ingrid, focus group discussion, November, 2010).

As Koszalka and Ntloedibe-Kuswani (2010) point out, students are becoming increasingly nomadic in their behaviours. Mobility was a strong theme across the students' voice studies both in relation to the ways they viewed themselves as learners and in the ways in which they used mobile learning to link various aspects of their 'life spaces' (Kolb & Kolb, 2005) to enable them to be anywhere anytime learners and to support continuity of learning. This involved learning on public transport, in parks and shopping centres amongst other places as they fitted learning in around other activities (Kirkwood, 2000; Murphy & Yum, 1998). For these learners they considered the ability to be mobile a critical aspect of their learning experience and essential to the ability to integrate learning into their daily activities. All of the participants were juggling busy lives (Kirkwood, 2000) and the ability to continue to learn whenever or wherever they were (Ramaprasad, 2009) was a critical part of their success or otherwise as learners:

I need to be able to learn wherever I am. A few minutes here, some time while the kids are playing ... my iPhone makes it easy for me to access PDFs and other materials wherever I am. (Christine, focus group discussion, November 15th, 2010).

I would say (technology) it's quite vital (for mobility). Only because I can log into myUNE from work or from my iPhone at work or at home. If I didn't have access to the internet I think my studying would be very limited (Margaret, focus group discussion, November, 2010).

However, the participants also expressed frustration that the institutions did not recognize their desire to be mobile learners and that the use of technology in many cases mitigated against this.

I have actually found the mobility of study is much easier in the history units - your material all turns up in hard copy - than I do with electronic resources ... Mobility is much easier if you have a hard copy ... . (Ingrid, focus group discussion, November, 2010).

While for some students, paper was still the mobile technology of choice (Smith & Smith, 2006), possibly at times through necessity, as pointed out by Ingrid, above, several had adopted mobile technologies to support their mobile learning. Two had made a deliberate decision to purchase laptop computers that would enable them to integrate their learning into activities both inside and outside the home.

I have lots of other interests ... so its very important to me to be able to take my work wherever I go. This year I have been able to do that because I saved up and got a laptop ... that's a big issue with me (Georgina, focus group discussion, November, 2010).

Whilst most utilized a mix of paper and mobile technologies to support their mobile learning, two had moved to entirely online learning, accessing learning materials and activities mainly facilitated by the use of mobile technologies. Some participants in this study suggest that this shift to mobile learning could be better

supported by institutions both through the design of learning and the use of institutional technologies that are better suited to mobile learning

These distance learners are actively appropriating mobile learning for a variety of learning activities. These included listening to podcasts on laptops, mp3 players and mobile phones, reading on mobile devices, participating in formal and informal online forums and transporting and accessing materials on portable hard drives.

Several of the participants found podcasts in particular to be useful for mobile learning. However in spite of this and their acknowledged pedagogical benefits for distance learners (Woo et al., 2008), some programs did not appear to integrate podcasts at all into teaching and learning activities and in others they were utilized inconsistently, highlighting the need to provide distance learners with materials suitable for mobile learning.

Along with this desire to be mobile the participants in this study expressed a desire for connectedness (Anderson, 2008). Mobile learning is an important part of this connectedness as it enables students to engage in a range of learning activities regardless of their location. As the results of this study indicate, these participants are willing to give up time independence for the ability to have the choice to participate in both formal and informal learning activities in particular. There is also an indication that these distance students are more willing generally to participate in synchronous time dependent activities. Consistent with Koszalka and Ntloedibe-Kuswani's (2010) perception of mobile learners, there appears to be a strong focus on place independence, with students demonstrating a clear preference to access their learning regardless of their location.

Being mobile learners relates not only to students need to make the most of every moment (Kirkwood, 2000), for the students it this study it can also have a positive impact on their sense of well being.

The other thing I like to do as well, sometimes if there is a lot of noise in the neighbourhood. I like to go to a park and study where it is quiet or down on the beach, or somewhere. So I like to be able to take my stuff wherever I go (Amanda, focus group discussion, November, 2010).

These finding confirms Traxler's (2007) view, that institutions are generally not currently able to support mobile learning from an institutional perspective. They also suggest that despite the recognition that anywhere, anytime learning is an essential element of the distance learner's experience (Anderson, 2008), current use of institutional technologies can mitigate distance learner's ability to be mobile learners.

IMPLICATIONS FOR PRACTICE

As society is becoming increasingly mobile and distance students continue to adopt mobile learning to support their learning across space and time, the findings of this study would suggest that there is an urgent need for institutions to specifically address ways in which they can support mobile, anytime, anywhere learning for their distance students. However, at this point there appears to be little consideration of how this aspect of distance learners' learning experiences might be effectively catered for by institutions, with limited focus on designing learning suitable for students' mobile devices. Additionally, while tools such as lecture recording podcasts are readily available and recognized for the pedagogical benefits they can provide to distance learners (Woo et al., 2008), as well as their ability to support anywhere, anytime learning, as the students in this study found, tools such as this that support mobile learning are not consistently included in all courses or programs for distance learners. Indeed, in general, attention to mobile learning for distance learners appears at best to be ad hoc and the outcome of individual staff's interest in and commitment to such activities rather than the outcome of specific institutional policies or practices.

Although higher education generally has been innovative in the use of technology, as mentioned previously it rarely occurs as a result of wide-scale institutional policy and practice. Furthermore, while numerous examples can be cited of the excellent work being done by individuals, the uptake through policy and practice appears to be falling behind (Smyth & Vale, 2011).. This no doubt points to arguments well-rehearsed, of the fast-paced development and consumption of technology by society at large and a lack of capacity in the education sector to respond whole scale and nimbly. As Traxler, (2007) pointed out the challenges can be clearly identified, are numerous and not to be underestimated. However they could equally be viewed as opportunities. Most importantly the learner is not well understood. Generalisations are easily made about delivering education to homogenous groups of students (Prensky, 2001) but as the study confirms here they are not as homogenous as first thought (Wood & Dodd, 2010). Additionally, as the results of this study indicate, learners are increasingly merging their personal and study habits. They grab small pieces of time and multi-task their

learning on the go. They could be beside the soccer field watching their children and accessing and working on the internet. They may well be on trains or buses watching recorded or streaming video of their lectures. Given these new learning habits the era of the mobile learner is a new group of students requiring new understandings and to be provided with enhanced opportunities to manage their lives whether personal or for study. Gone is the fixed location for learning whether the learner is in a traditional on-campus mode or if studying at a distance.

Barnes and Tynan (2007) propositioned that students are already wired and this presents opportunities for the higher education sector to realize the idea of a new kind of university that has as its focus student-centred and now mobile oriented learning environments. There is a need then to provide staff development opportunities that enable staff to consider how they might make the most of the opportunities offered by these tools and to 'reimagine their teaching' (Steel & Andrews, in press). As Kirkup and Kirkwood (2005) state, staff need to move away from the adoption of technology towards what they already do. The opportunity exists to reconceptualise what is possible with a mobile learner cohort. For universities, however this is a considerable challenge as staff have competing demands on their time and are not from a generation who has grown-up with technology as a key ingredient of their lives. Additionally, as Corbeil and Valdes-Corbeil (2007) pointed out in their study into staff and student readiness for mobile learning, while many staff own and use mobile technology and feel prepared for mobile learning they recognise that converting existing courses to a mobile learning format is a massive undertaking. Barnes and Tynan (2007) also observe that while the passive pedagogies of Web 1.0 are far behind us, staff development, infrastructure, resources and policy and procedures are sorely needed to make effective use of emerging technologies for teaching and learning activities.

Policy and practice across the sector regarding mobile learning, mobile content and institutional commitment is varied. A desk top scan across numerous university websites is not revealing, with distributed leadership and ad hoc planning. It appears research is sorely needed to bring forth the pressing need for such guidance. Interestingly there are standards that are evolving around mobile learning content and certainly various platforms such as Symbian, Android, iOS and Windows, in descending order, provide some clue to global directions that will be significant to Universities in their strategic planning (Gartner, 2010). Standards will be important in this debate to ensure interoperability, usability, and accessibility issues are all addressed. The World Wide Web Consortium has already established the Mobile Web Initiative (MWI, 2011) to address these issues. The MWI already has 300 plus members and their work is important for business and education alike. As we have found, learners are not all going to be using the same devices.

Content and resources are not as easily managed for format, delivery or for standards. The ability of an institution to be able to produce multiple formats from one source remains a challenge. Middleware such as M-Context, for example are attempting to provide services whereby content can be downloaded to iPads or iTouchs, but more work is required to meet other popular standards such as Symbian and Android. As already mentioned, standards are becoming increasingly important and non-proprietary solutions that can meet the diversity of mobile devices on the market is essential. For institutions this becomes increasingly important as they develop learning strategies that can meet the demands of mobile learners and also be pedagogically sound. It appears however that the range of devices and their underlying platform capabilities, including screen size, input mechanisms, file type, accessibility and cost, for example, will impact on how universities move forward in addressing the diversity of devices which students and staff alike may wish to use for learning. Some institutions align themselves for market advantage with particular systems, however communicating this to their students and managing the diversity of devices remains a huge issue. In some cases institutions are supplying devices such as iPads (e.g. Trinty College Melbourne, University of South Australia, Curtin University) or iTouch (Wolverhampton University, UK. etc.). But what of those students who already use platforms that are leaders in the market such as Symbian and Android? If society at large is pursuing mobility and flexibility then so too institutions may need to consider this as part of their strategic positioning and the consequent policy and procedures to enable them to be legally competitive in the higher education market place.

It appears that mobile learning will enable the sector to realise O'Reilly's (2005) arguments that the consumption and remixing of data is more than possible to deliver rich user experiences. Via the internet, learners today can do as much as they do in their personal lives in searching for content, building content and collaborating with others via social networks (Fumero, 2005; Hinchliffe, 2007). For universities the consideration of how learning takes place, what is learned and how it is learned needs to be more aligned with the anywhere and anyhow generation. There is an argument that what is needed at the 'chalkface' is an understanding and consensus about what constitutes knowledge in the new mobile environment and what role the teacher and student have.

What of pedagogy for the mobile learner? In 2005 Siemens pointed to a new theoretical framework called connectivism. Its key principles are very much aligned with the mobile learner and their desire for learning on the move. As a theory it positions the learners as holding collective truth and in enabling the connecting of people and information through a specialised group. For example social media allow groups of individuals to build ideas together and to collect in one place knowledge. By allowing the learners to choose and make decisions they themselves make connections between ideas, disciplines and fields. The teacher becomes a mediator of learning rather than a deliverer of fixed ideas.

What this might mean for the mobile learner is a curriculum design that in itself is intrinsically 'mobile'. It is shaped around a teacher who mediates a learning experience with learners which is more about drawing upon connecting people who build ideas that shape individual and collective knowledge. The curriculum might draw upon content across the internet and allow students to construct an aggregated knowledge base that has been built upon developing transportable skills relevant to a modern society where graduate attributes become perhaps more important than the shifting understandings that today may be true but tomorrow not.

In addressing the changes in distance learner's

CONCLUSIONS

This study indicates that some distance learners are seeking more personalised approaches to learning that are particularly enabled by mobile learning. This presents opportunities for higher education in particular to recast ideas about how and when learning occurs. As the world becomes more mobile oriented the phrase anywhere anytime is not just a catch for an unknown future. The future is here and a convergence is occurring that requires attention and not least to recognise that:

- Higher education students and University staff own and use a variety of devices for life and learning
- Universities cannot be device specific in creating solutions for accessing learning in online environments
- Learning design is incorporating Web 2.0 applications at great speed
- Standards are an important consideration of the future
- Leadership and strategic directions need to be more than ad hoc
- The internet is driving new forms of social connectivity and engagement
- Mobile ownership (across devices) is increasing and outstrips the Australian population and globally in high growth.

The phenomenological study into students' experience with information communication technology (ICT) and distance learning reported on here suggested that many distance learners are essentially becoming mobile learners and that as Traxler, (2007) pointed out institutions are largely unprepared for this.   Consequently, at this stage little appears to done to support mobile learning for distance learners at an institutional level, or even to recognise that their preferences in this regard are changing. However, the findings of this study would suggest that exploring ways to leverage distance learners' use of their own mobile and other personal technologies to support teaching and learning activities could have particular benefits in creating more personalised approaches to learning that better reflect the indivualness of these students' experiences . The advantages for institutions is clearly to be had where collective understandings are developed for not only the challenges but increasingly viewing these as the opportunities-perhaps even for market advantage.

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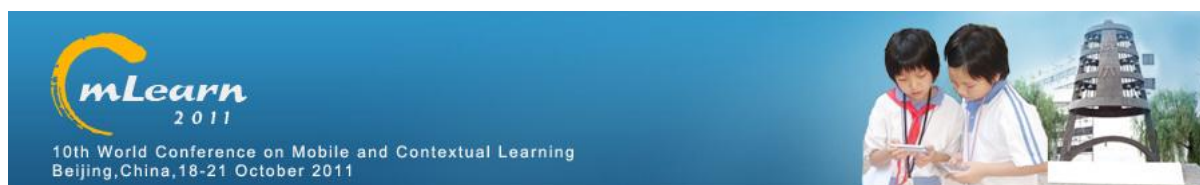
e-Learning Content's Template Design with Subjective Metadata

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ABSTRACT

As e-Learning becomes very popular these days, the requirement of quality learning material is huge. The process of developing quality content must be effective and easy for rapid deployment in a Learning Management System. A template-based approach can help the content creator to develop learning content easily. Templates for e-Learning include technical features and help the content creator to develop quality content without much knowledge of authoring tools. The purpose of the paper is to show how the structure of e-Learning content can be specified in the form of template models. In this paper, the template model and its associative primitives are designed based on some pedagogical approach and is defined by Subjective metadata. The Subjective metadata plays an important role in guiding and controlling the content development process. The aim of the paper is to support content developers with templates, which present ready-made model that guides content creation.

Author Keywords

e-Learning content, Template, Subjective metadata.

INTRODUCTION

The core of any learning process is the content and the way it is delivered to the learner. The better the-Learning content is built, structured and tailored to learner, the more efficient the learning process is. The content plays a major role independent of the form of education because ultimately the content is what student learns. So, the content should be sufficient and necessary to meet learner's requirement.

Today, e-Learning is widely used in educational purposes everywhere. With the increasing popularity of e-Learning, there is a need to transfer the courses from traditional form of education to computer based education. But the instructors often are not aware of the facilities the e-Learning environment provides. In this paper, a model template has been proposed that helps Instructor to develop contents with greater ease. Instructor does not need to know all details of complex instructional design process for e-Learning content. Content developer only has to choose an appropriate template and fill it with proper content.

Metadata is a structured data, which describes the characteristics of a resource. It is often called data about data. There are two types of metadata- Objective metadata and Subjective metadata. Objective metadata is generated automatically and describes characteristics such as file size, date, author etc. Subjective metadata is more varied and often describes the most useful information about a content object, because they capture undocumented knowledge, perspectives, context etc. A single piece of object can have unlimited number of metadata records (Wagner, 2002).

The objective of the paper is to design the template model in terms of Subjective metadata. The metadata descriptions i.e. attribute and value of the model and its associate parts helps guiding and controlling the process of content development.

LITERATURE REVIEWS

Previously, the e-Learning content published in HTML documents had solid and inflexible structures of big and monolithic blocks of information. However, along with the advancement of technology a new approach of creating content from Learning Object (LO) almost completely replaced the old model of learning content.

The-Learning Technology Standards Committee (IEEE LTSC, 2002) defines LO as "an entity, digital or non-digital that may be used for learning, education or training". The LOs have to be linked to the context of use

in learning environments, so additional information to LO that allows an instructor to know how to use the object in educational setting. The IEEE LTSC (2002) develops Learning Object Metadata Standards that provide the necessary context for the educational resource.

In (Boot et al., 2000), the authors suggested using building block method that provides pre-structured software templates. Templates consist of empty courseware structures to be filled with content. These structures incorporate sound didactical principles and advanced technological features. Later in (Boot, 2001), the author has shown in Template project that it is possible to support developers in creating courseware for relatively simple learning objectives but with a high level of technical complexity and interactivity. In BAOZ project the author has shown that it is possible to embed more advanced didactic functionality such as, case based. The Case based templates provide cases that contain a generic navigational problem that unfolds itself within a simulated situation.

In (Jack, 2008), the author explores the practical challenges of adopting a template-based approach to e-Learning design. The author identifies its advantages and pointed out 8 challenges for implementing template-based training design, and offers a list of additional resources on using template-based approach in e-Learning. In (Wagner, 2002), the author has designed Learnativity Model, that illustrates the relationship among varying kinds and sizes of data files likely to be part of any e-Learning or knowledge management solution. The model has five definite levels.

The (CISCO System RIOS, 99), significantly contributed into the LO model by designing Reusable Information Object (RIO) Strategy. An RIO is a granular reusable chunk of media independent information. An RIO can be developed once, and delivered in multiple delivery mediums. Each RIO consists of content items, practice items and assessment items. Individual RIO's are combined to form a structure Reusable-Learning Object (RLO). Combining an Overview, 5 to 9 RIOs, Summary and Assessment creates a RLO. RIO's are classified into five types based on modified information mapping with Merrill's component display theory and Bloom's Taxonomy of Educational Objectives: concept, fact, procedure, process and principle. Besides this classification of RIO's, CISCO also provided templates and guidelines for each type of RIO.

Richard Mayer and his colleagues at the University of California at Santa Barbara have experimented on how to best use audio, text, and graphics to optimize the learning in multimedia. In (Clark, 2002), the author summed up the six media elements defined based on Mayer's work along with supporting examples, psychological rationale, and research.

The author (Telnova, 2005) have designed template as a framework for building LO. The templates have been designed for creation of e-Learning content depending upon Task Based Learning (TBL) pedagogical approach. The goal of this template was to support content developers and facilitate the process of creation of modules (courses) that include tasks as one of the main components, and allow detailed description of the task according to TBL pedagogical approach. In this paper, a template model based on subjective metadata has been proposed.

PROPOSED WORK

Metadata is used to store data about data in attribute and value form. But, in this work, metadata is used in a different way. All the features, characteristics of the LO model are stored in attribute and value form of subjective metadata. The attributes and its value of the LO model helps designing the template for the Learning Object (LO).

A Learning Object (LO) has a specific structure and it is built up with a number of blocks known as Information Object (IO). Each of the block or Information Object (IO) has certain features, properties, characteristics, particular assets and its own way to sequence or orient the assets. The main objective of this proposed work is to specify all the features, characteristics and information about the models or its building blocks in terms of proper attribute and value form i.e. subjective metadata description. Learning strategies and sequence of events depend on the pedagogical approach used for course development and delivery. Template should vary with respect to different pedagogy.

The LO model has a definite structure and is defined by a set of characteristics, property and information. The Subjective metadata description of the model i.e., the attributes and values give a brief overview of the model and its scope, guidance and all the features to the Content developer. An example of metadata description of a LO is given in Table 1.

Attribute	Value
Name of the LO	----
Pedagogical approach	Task Based Learning
Activities included	Reading, Watching.
Supported media	Text, Image, Video, Animation, Audio.
Number of IO	Up to max 5
Name of the IOs	Introduction, Description, Operation, Example and Exercises

Table 1. The subjective metadata description of a template model.

In subjective metadata description, the attributes that provide guidance, give hints, state important facts can be called descriptive attributes. The attributes that generally states what are the fields, how many can be included, are called control attributes, because its value controls the process of content development. The control attributes and its value helps designing the structure template for the learning content or LO.

An IO or building block is consisting of a number of different assets. The content developer needs to fill up the template provided by each building block, because it is the combination of the blocks that makes a LO or learning content. The template should support different input formats, and must have provision to accept the input data. All the features, characteristics, properties, guidance's of an IO are also converted to appropriate metadata description. The descriptive attributes of an IO guides the content developer by providing scope, hints of the IO. It guides the Content developer about what to jot down, options available and how (e.g. page theme) under an IO templates. The control attributes of an IO provide constraint, restriction or flexibility on different assets used in Content Development. For example, if in the metadata description of an Information Object(IO) shows, number of images to 3, then the template reserved only three spaces for images in that IO. Apart from that, predefined pages or patterns in the form of embedded themes and models are offered which allow creating instructional content using specific page style. Events, activities can also be incorporated in IO. An IO may consist of a number of sub IOs. An example of a metadata description of a certain IO and sub IO's are given in Table2, 3, 4 and 5. Let the "Concept" IO is consist of four sub IOs. These are "Introduction" (Table 2), "Definition"(Table 3), "Fact"(Table 4) and "Example"(Table 5).

Attribute		Value
Name		Introduction
Explanation		Brief description about the topic, its requirement, and utility.
Obligation of use		Mandatory
Hints		Grabs learner attention
Asset type		Text
Attribute	Value	
Size limit	Up to 500 characters	
Asset type		Image
Attribute	Value	
No. of images	5	
Page Theme		Text with Image

Table 2. The subjective metadata description of sub IO "Introduction".

The first sub IO is "Introduction". While creating the subjective metadata description of the sub IO "Introduction", the population of the attributes and its values must reflect the IO's characteristics. The 'Explanation' defines what the IO is all about or its requirement. The attribute 'Asset type' signifies that only text and image can be

incorporated in the IO. 'Hints to write' provides guidelines to write the content. The template structure for writing sub IO "Introduction" is to be developed from its metadata description (refer to Table 2.) with exact provision. Then the content developer fills up the template of the IO with proper contents. The population of all the attributes in the given sub IOs helps the content developer in guiding and controlling the content development process.

Attribute	Value
Name	Definition
Explanation	Short and concise illustration of the term being defined.
Hints to write	To the point and brief statement
Asset type	Text
Attribute / Value · Size limit / Up to 200 characters	
Page Style	Text

Table 3. The subjective metadata description of sub IO "Definition".

Attribute	Value
Name	Fact
Explanation	A detailed description of the concept.
Obligation of use	Optional
Asset type	Text
Attribute / Value · Size limit / Up to 500 characters	
Asset type	Image
Attribute / Value · No. of images / Up to 2 images.	
Page Style	Text and image

Table 4. The subjective metadata description of sub IO "Fact".

From the metadata description of the sub IO "Fact "(refer to Table 4) a template for the sub IO "Fact" with exact provision appears before the author. The content developer will fill it up with proper content. The template structure of the IO "Fact" is shown in Figure 1.

Attribute	Value
Name	Example
Explanation	A prototype or model, which others can use to understand.
Obligation of use	Mandatory
Number of examples allowed	2
Asset type <table><tr><td>Attribute</td><td>Value</td></tr><tr><td>Size limit</td><td>Up to 500 characters</td></tr></table>	Text
Asset type <table><tr><td>Attribute</td><td>Value</td></tr><tr><td>No. of images</td><td>5</td></tr></table>	Image
Guideline to use	Use example in different context from simple to complex.
Page Theme	Text with Image

Table 5. The subjective metadata description of sub IO "Example".

The subjective metadata description of the sub IOs and IOs distinctly illustrates all the features, properties in terms of attribute and value form. The values of control attributes help developing the template for the IO or sub IOs. The way the IO's or sub IO's metadata is created, the template is organized in the same way. The design of a template is completely regulated by its subjective metadata description. The change in value of any control attributes directly results in the structure of its respective template.

Depending upon the metadata description of the LO model and its associative IO, the content developer needs to choose most suitable structure template for the Learning Object. Once the template structure for LO is chosen, all the IO's in that model template appear to the content developer one after another with their respective metadata description and empty template. The template should have provision for incorporating various input provisions, events, activity etc. The descriptive attribute guides the content developer giving hints, explaining matters. The control attributes control the content development procedure by providing various constraints, restriction and flexibility. No extra tutorial for guidance is required, everything is provided in metadata description.

Customizable model template can also be defined by selecting a number of different Information Objects from different LO models. Customizable Information Object can also be designed provided that all the properties, characteristics should be defined properly in their respective metadata description such that it can be used to provide a template and helps the content developer to understand the IO template properly.

CONCLUSIONS
The main goal of this paper is to help content developers by ready-made model or template for developing e-Learning content. The model template for Learning Object and its associated Information Objects are defined by means of subjective metadata. The control attributes helps designing the structure template for the learning content. The descriptive attributes guide, provide hints to the content developer towards producing a well-structured Learning Object. A number of instructional methodology and pedagogical approach could be incorporated in Learning Object design provided all of the features are defined in terms of subjective metadata.

A prototype is being developed, that helps to design and develop the structure template for learning content from its subjective metadata description. The design of the structure template must follow the way attributes and values organised in their metadata description. The Content developer only has to choose an appropriate template and fill it with proper content. Thus the content development procedure becomes very easy, quicker and effective.

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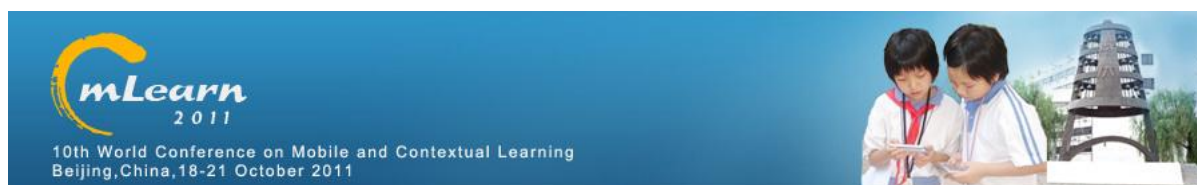
"m-Learning Not an Extension of e-Learning" based on a Case Study of Moodle VLE

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ABSTRACT

Learning through mobile devices is considered to be the key feature that we can observe in m-learning. However, m-learning contains both technical and pedagogical issues to be addressed when such a learning service is provided. Technical issues are the first obstacles that must be addressed in developing m-learning interface for a Virtual Learning Environment (VLE). However, when we develop an m-learning extension for existing online learning programmes overcoming technical issues, we have less opportunity to change the pedagogical structure since the most of the learners has bonded and related through e-learning VLE. In this paper, we are presenting technical development work that we carried out to develop an m-learning extension to Moodle based VLE at the University of Colombo School of Computing (UCSC) and its initial evaluation. Since the majority of the learners who follow all these programs have mobile phones and it is higher than those who possess a laptop/desktop computer with Internet connection, we believed this new development could bring a value added service that learners would like very much. However, we failed to promote the m-learning extension among active e-learners in our online blended learning programmes. In our investigation, we discovered that the m-learning cannot be promoted as a value added service for the e-Learning based framework. Learners do not receive a significant benefit compared to the cost they incur to interact the learning service. Both pedagogy and technical infrastructure must be considered together not as an extension of existing learning service but to provide a new learning service in the m-learning. This paper also discuss the initiative that was taken to develop an m-learning platform for Moodle, open source learning management system which was used to develop the VLE of UCSC. It includes how mobile browsing, mobile applications and Short Message Service (SMS) were designed and developed to access learning resources and activities to interact with other users who were facilitating or following on-line courses.

Author Keywords

m-Learning, e-Learning, Virtual Learning Environment (VLE), Moodle, Learning Pedagogy

INTRODUCTION

Information Communication Technology (ICT) based techniques can be effectively used in the learning and training process as they minimize the limitations of time, location and pace. This was the main reason for e-Learning to become popular alternative for traditional face to face (f2f) learning during the last decade. In the f2f learning environment, teachers, learners and resources are connected within a small physical space. e-Learning enables distance learning by making use of Web/Internet based technologies to provide a more flexible and convenient learning environment.

During the last few years with advances in mobile technologies and devices, such as smart phones and pocket PCs, e-learning trend is mixed and enhanced with m-learning alternatives. Hence, it is sometimes difficult to understand whether a particular service is based on the e-Learning or m-learning. Unfortunately, some initiatives promote the e-learning as the m-learning when the learning takes place through mobile devices. For example, "Mobitel m-leanring" [http://www.mobitel.lk/support/mlearning.html] is highly publicized m-learning initiative [GSMA 2010]. However, when we analysed this service we identified learners are accessing an e-learning based learning management system and streaming video content of a blended course using laptops and wireless broadband dongles. Public who are not very clear about the difference between e-learning and m-learning, believe what service providers are saying. Politically, these types of initiatives can be defended since the m-learning definition [http://en.wikipedia.org/wiki/MLearning] still does not consider the pedagogical requirement of m-learning and it purely depends on technical features. On the other hand, without the technical infrastructure it is a dream to talk about the m-learning, and the distinction between m-learning and e-learning must be clearly visible to all stakeholders. Whether the m-learning could deliver better service than e-learning as a value added service, is an open question. This hypothesis is studied and presented in this paper.

What is the relationship between e-learning and m-learning? [Keegan 2002] Without e-learning infrastructure can we introduce m-learning [Kristine 2007]? Technology could drive us as it happened in many other cases but we should not let the technology to take us to anywhere. When e-learning was introduced, the same thing was discussed with respect to f2f learning. Online/Web based facilities were initially introduced as a supporting facility for f2f classes. Later, it was integrated to develop the blended learning environment. In the next stage, e-learning was introduced completely removing the f2f interaction. However, e-learning is not a teaching environment but a learning environment. Those who try to practice the traditional f2f learning through e-learning always find failures because of the pedagogical differences. Failures are good learning lessons that help many people to correct their mistakes. It is difficult or painful to carry out the paradigm shift but it will bring many benefits. The similar paradigm shift is required from e-learning to m-learning. This was the main lesson learned in this case study of developing an m-learning extension to the existing e-learning framework.

Modular Object Oriented Dynamic Learning Environment (Moodle) [http://www.moodle.org] is the well-known open source software that has contributed significantly the paradigm shift from classroom based learning to online learning. Many educational institutes have started using Moodle to experience the online learning. University of Colombo School of Computing (UCSC) also developed their online learning service platform using Moodle starting from 2005. It was initiated with the blended learning courses of internal degree program and later was extended to fully online degree programme called (Bachelor of Information Technology) BIT [http://vle.bit.lk]. Majority of the users who follow these courses have mobile devices and the number of users possessing a mobile device is usually higher than those who possess a computer with Internet connection. Therefore, we believed that there was a significant opportunity to use mobile devices in the learning environment.

Mobile learning could be defined as an extension to the e-learning platform blurring the temporal and geographical barriers by taking advantage of mobile technologies [GSMA 2010]. Unlike in e-learning, the learning process is not restricted to a prearranged, fixed location where the Internet connection is available and learning could happen with the movement of learner as far as he/she has the mobile devices and Internet connection. Hence, m-learning could be used to enhance the learning activities resulting increased efficiency and effectiveness of the learning process.

However the designing and developing an m-learning extension as a software solution is not a straight forward thing. Moodle is not preliminary designed to be accessed through mobile devices but the constructivism pedagogy supported in Moodle VLE could be applied to design the interaction in m-learning. The Moodle layout is not suitable to be accessed from mobile devices because of the java script support. Number of issues and challenges has to be addressed when extending the Moodle based e-learning platform to integrate with an m-learning extension.

The paper is organized as follows. Section 2 presents the background for this case study. Section 3 presents how the SMS facility was integrated with the existing leaning process. Section 4 describes how the mobile phone browser and mobile applications have been used to provide the learning activities at VLEs of UCSC. In Section 5, we discuss the outcome and lessons learned in this exercise both technically and pedagogically. Finally, we conclude the paper in Section 6 together with our suggestions to develop m-learning extensions.

BACKGROUND

When we are struggling to provide a good e-learning service with technology changes, competitors carry out marketing campaigns announcing that they are providing m-learning service [Sunday Times May 2011]. In the business world, novelty is marketing to introduce new things. As academics, we should take more precautions when we introduce new things for teaching and learning. Few years ago, it took a great courage for us to integrate e-learning in higher education programmes, although we are still not getting the best of it. When the m-learning was discussed, we understood it as a something built on top of e-learning. In the real life, if the second floor (e-learning) is not strong enough, then the third floor (m-learning) will have many instability problems. On other hand, you do not want to finish everything to start a new thing. For outsiders, the development is a waterfall but it is incremental internally. At the same time, "You do not want to know everything to do something" is a valid in the agile software development. After several discussions, we started our m-learning development while experimenting software architecture and other projects related to Moodle.

We analysed the existing literature to identify the initial features to be selected for the first extension of m-learning development. Several initiatives were identified with respect to m-learning applications, namely; 1) Sending SMS block for Moodle 2) Mobile Learning Engine (MLE), and 3) Moodle for Mobile.

Sending SMS block [Reyes, 2008] gives the basic functionality of sending a SMS using Moodle to a selected group of users. This block was used as the base for developing SMS integration for the proposed m-learning extension since it offered the basic functionality, interfaces and easy customization. However, sending SMS block didn't keep a track of the sent messages to implement a discussion among participants similar to a forum in the

VLE. Several technical drawbacks of SMS block and enhancements were identified in order to develop a SMS based m-learning extension for Moodle VLE.

MLE (Mobile Learning Engine) [MLE, 2010] is a fork of MOMO (MOodle MObile) project [MOMO, 2010]. MLE enables access to the moodle virtual learning environment via a J2ME applet installed on the user's mobile device. There are two main components in MLE namely, 1) **Mobile Application** and 2) **MLE-Moodle plug-in**. Mobile application allows users to access and participate learning activities in the course pages. For example, this allows learners to attempt online quizzes, upload assignments and do other kinds of activities by using a mobile device. Hence, users can download the content from the Moodle and access the content as offline content. The MLE-Moodle plug-in gives another facility to access the Moodle as well as through the mobile browser. Moodle for Mobiles (MOMO 2010) is a project for accessing Moodle through mobile browsers. It uses compact HTML (CHTML) that could only be used with some specific mobile phone models such as DOCOMO (DOCOMO, 2010).

After analysing features, the learning pedagogy and activities that take place in the UCSC Moodle VLEs, MLE plug-in was selected as the base to develop the m-learning extension, because of its comprehensive features and ability to operate on mobile phones used in Sri Lanka. Since the current m-learning initiatives in Moodle are open source development, we decided to share our developments with Moodle community. After completing the first version of m-learning extension, we carried out an evaluation of our approach towards the m-learning as an extension to e-learning based Moodle VLE. This paper summarizes these aspects.

SMS EXTENSION TO MOODLE VLE

While investigating Moodle and its related m-learning initiatives, we conducted a survey to identify the use of mobile phones by the students of UCSC VLE. More than 85% of the students uses mobiles. Their main purpose was to communicate using SMS among the friends and relatives, which is very economical compared to voice calls. All types of mobile phones supported the SMS facility, irrespective of their generation. Therefore, we assumed there was a significant potential to use SMS based interaction to increase the student participation in learning activities [Tina Lim 2011]. Hence, our objective was to develop a SMS based discussion forum in courses to keep the learner engage in learning process. At the same time, we decided to develop SMS based polls to obtain different learner opinions as a feedback mechanism. However, sending SMS Block [Reyes 2008] was lacking in those features. Hence, we extended the SMS sending block to include those two features. These extensions for SMS Block were informed to the Moodle community (Wickramasinghe, 2009a).

Design of SMS based Communication and Forums

Apart from subjective discussions [Tina Lim 2011] [Agnes 2007], SMS messages can be used to communicate important notices to students by facilitators, such as cancellation of a lecture, extension of a deadline, thus providing value added services to the students when they are following a particular course. However, only privileged users (facilitators) are allowed to send SMS messages since otherwise it could create unwanted disturbance to learners. At the same time, facilities were developed to select users in a course (all users, a specific group or specific individuals) when SMS messages were sent from Moodle VLE.

To keep a record of what sort of interaction took place through SMS messaging all these SMS messages are copied to a SMS forum in the course page. Eventually both the registered learners who do not have mobile devices to access VLE or those who are not willing to access using mobile devices, would not be discriminated. Hence, these sent SMS messages are directly added to the respective news forums in the course page. The sent messages will appear in "site news" forum of Moodle VLE if the message is sent by the administrator while it will appear in "course news" forum if it is sent to a particular student category by facilitators of the relevant course. By adding the sent messages to forums the users could keep a track of sent messages, as illustrated in the Figure 1.
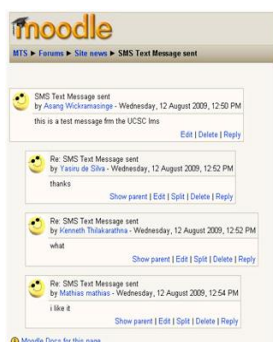
Figure 11: Integration of SMS with moodle forums

Figure 12: Reply format for the forum SMSs.

Since SMS is a two way communication mechanism, we extended the module allowing learners to reply SMS Forums defined in the courses. Students' replies are listed in the SMS Forums (Figure 1). Respective forum was identified using a unique forum id which must be inserted as the first character sets in a message. An example is shown in the Figure 2.

Design of SMS based Polls

SMS poll is an interesting feature to obtain the learners' participation. At the same time, it could be used to collect the feedback/opinions of students with respect to activities in the course. Thus this would increase the interactivity of the learners. However, we allow only privilege users of the course, to create SMS polls in a course. When a privileged user creates a SMS poll for all students or selected student groups, a message with poll questions and available voting options were sent as a SMS. Two or more suitable options/answers should be defined in the poll question as shown in the Figure 3. As in the SMS forums, the poll questions are also added to the sent messages and the reply format is appended at the end of the message. Student can send their feedback using SMS in the given format as shown in Figure 14. The Figure 15 shows the poll question displayed in a mobile phone.

Figure 14: Reply format for the Poll SMS

Figure 13: Creating poll interface in moodle VLE
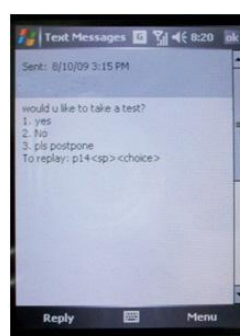
Figure 15: SMS poll question in a real device

Another important feature of this SMS poll module is that the received replies are shown as anonymous in the presentation layer. However the received replies are correctly validated at the database level. By showing the replies as anonymous in the presentation layer, more freedom and flexibility have been given to the students to select the most appropriate choice. The replies for the poll questions are presented in graphical formats and in numerical formats as shown in the Figure 6.
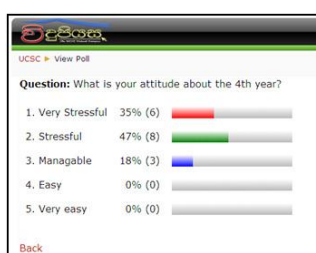
Figure 16: SMS Poll in Moodle

MOBILE INTERFACE FOR MOODLE VLE

The main purpose of developing a mobile interface for UCSC Moodle VLE is to facilitate "the learning on the go" [Bryan 2004]. Students' primary requirement is to access learning content whenever they need irrespective of the fact that whether they have a computer and Internet connection. Mobile accessibility would allow them to go through the content many times during the day whenever they want. However, we also identified a several important facilities they would like to access through mobile interface such as accessing quizzes, participating in forums, and uploading assignments. Submission of assignments before the given deadline is the most common requirement and many students prefer to delay the submission until the last minute.

Moodle (1.9 and before) was not developed to be accessed from mobile devices directly. In our technical analysis, we identified following limitations that were negatively affecting for the mobile accessibility of Moodle VLE.

Use of JavaScript

Moodle layout (three column layout not suitable for the mobile devices)

Network usage (Moodle themes and other content)

Interaction model (Not suitable for the mobile devices)

Moodle uses JavaScript for validations and other purposes. However, many mobile web browsers still do not fully support JavaScript. The three column layout in Moodle is suitable for large desktop screens. Many mobile devises have smaller screens with height greater than the width, and three columns lay out renders unsuitable in this context. Moodle themes also consume a lot of bandwidth when loading a page into a mobile device and users experience a time delay.

The GUI interface of Moodle is designed considering WIMP components in a desktop environment and generally it requires a pointing device to access the active links and content. However, in many mobile environments except the smart phones and pocket PCs, mobile devices do not have the capability to point an object on the screen. Therefore, interaction issues need to be addressed, so that the links are accessed easily with few numbers of keys.

When we experimented the MLE moodle plug-in to access Moodle content from mobile devices, we observed several bugs which prevented us from using it to complete activities. Three main bugs that we identified were,

Assignment upload

File upload to Moodle forums

Displaying courses

Since the assignment submission facility through mobile devices is a very important requirement to be supported through the mobile devices, we investigated the relevant codes to correct them. MLE moodle plug-in also gave errors when displaying courses properly on mobile devices. It was mainly due to MLE plug-in that was unable to handle "div" tag with "style" attribute. After these bugs were corrected, the module was extended to requirements we identified for the mobile interface of Moodle. MLE developer community was informed about these bugs correction and development of new codes (Wickramasinghe, 2009b).

Accessing Moodle through mobile browser

The MLE plug-in was the main component to access Moodle through a mobile browser. It addresses the issues in accessing Moodle via mobile devices in several ways.

Simple Interface

MLE facilitates users to access the Moodle via a simple interface. This interface allows them to access almost all the core features of the Moodle VLE.

Single Column Design

Single column design allows users to access the content easily when it is viewed from a mobile device. This design decision directly address to the screen size limitation in mobile devices.

Minimal Content

Minimum amount of content is used to design the user interface. Less number of images has been used. Most of the formatting is done through CSS (Cascading Style Sheets) tags and thus requires less network bandwidth.

Arrangement of URLs

The main URLs are arranged in a list from the top to bottom of the screen. It is convenient in accessing the links with navigation keys in a mobile device. This design decision transform the interaction model woven around pointing in moodle to an interaction model based on navigation keys on a mobile device.

Mainly there are two advantages of using the mobile browser for accessing Moodle. They are; 1) no separate applications to be installed, and 2) easiness of use (same as accessing a mobile web site). This method of accessing Moodle also carries two limitations; 1) the user to be online for accessing content, and 2) unable to use the device specific features.

Accessing Moodle via mobile application

J2ME and Symbian C++ are some technologies used to develop such applications. The MLE application was developed using J2ME and it has many features compared to Moodle access via mobile browser.

Improved functionality

Mobile application allows one to access the messages sent from the Moodle and use the mobile phone capabilities such as taking snapshots or recording/uploading videos.

Less network bandwidth utilization

Since the presentation is developed inside the mobile application, only the content is transferred.

Offline content support

Mobile application has a feature to store as a local content which can be viewed without network connection.

Bluetooth content sharing

Using the Bluetooth technology in J2ME (JSR-182), students could share local content with peers.

Students of Moodle VLE could gain many advantages by using the mobile application, 1) Offline content support, 2) Offline content sharing via Bluetooth and 3) Less network usage. However, there are also some limitations such as 1) Mobile application has to be installed and 2) The extent the mobile device support to J2ME has an impact on additional features of the application.

EVALUATION

After developing the first version of Moodle m-learning extension, we deployed in the active Moodle VLE instances at UCSC. We also evaluated the cost-benefit analysis of SMS gateway vs. Sending/Receiving Messages using a mobile dongle. For the initial implementation, we decided to go ahead with the latter alternative, for which we defined a unique mobile phone number for each Moodle VLE instance at UCSC. Since different instances of the institute were installed on different server machines, we were able to assign separate phone numbers. Since unavailability of drivers for Linux operating system and sending/receiving SMS messages from the Moodle Instance was not straight forward for Moodle 1.9 and 1.8, more experiment and technical work took more time before starting the service operational.

The very first task was to inform the users about the facility asking them to update profiles with mobile number. However, it was difficult to convince some teachers and students and they were unnecessarily afraid of their privacy and additional cost that could incurred when sending SMS messages. Figure 7 shows an open SMS forum to test the feature.
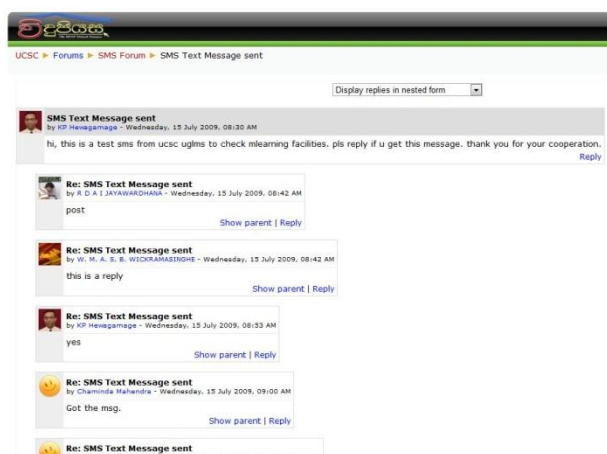
Figure 7: SMS Forum – Posting delivered as a SMS and replied SMS messages listed as a discussion forum

In our evaluation, we got to know that teachers were only interested in using SMS to inform urgent messages such as the cancellation of lectures. However, some teachers were not willing to use such services since the cancellation will be recorded in the VLE. Teachers didn't find any pedagogically better alternatives compared regular online forums which can be subscribed using email. There were no restrictions on the message length in normal discussion forums but SMS forums were restricted with respect to the number of characters in a posting. Hence, majority of teachers believe SMS forums are not good alternative or better mechanism for discussions since it incurs additional financial cost too.

Students were very much interested about the SMS facility in the VLE but they were not very happy to use it extensively since they didn't receive others postings. Some students were concerned about the additional cost and they thought online discussion forums are more interactive. However, we didn't want to activate the feature of redistributing messages through SMS since it is not cost effective and it may create some unnecessary disturbances.

Both teachers and students liked the SMS Polls. However, they were not interested in using them productively. Teachers did not like the restrictions in the messages and options when creating a poll. They also didn't need immediate responses for polls and preferred to keep them open. Students were more concerned about the privacy if it contained very sensitive questions and choices. Simply, SMS polls couldn't add a new value for the regular learning process in the Moodle VLE. We also evaluated mobile interface for Moodle VLE technically and pedagogically. Table 1 shows the comparison.

Mobile Browser	Mobile Application
Ease of use, no separate application installations.	Application should be installed
No off-line content support.	Supports off-line content
Must have a mobile network to access the content.	Usable where there is no mobile network
Same features for all the users.	Device dependent features
More network usage	Less network usage
No sharing through the browser	Share resources via Bluetooth with peers
No support for flash animation and SCORM lessons	No support for flash animation and SCORM lessons

Table 10: Comparison of mobile browser vs. mobile application in accessing content in Moodle VLE

To facilitate users, we defined short URLs to access the m-learning extension through their mobile phones. For example, http://vle.bit.lk/m is the entry point to access the m-learning extension of BIT. Some screenshots of the m-learning extension of BIT VLE are shown in the Figure 8 and 9. Students were informed about the mobile application which they can install on their mobile devices (http://vle.bit.lk/mod/forum/view.php?id=4224).

(a)   (b)   (c)
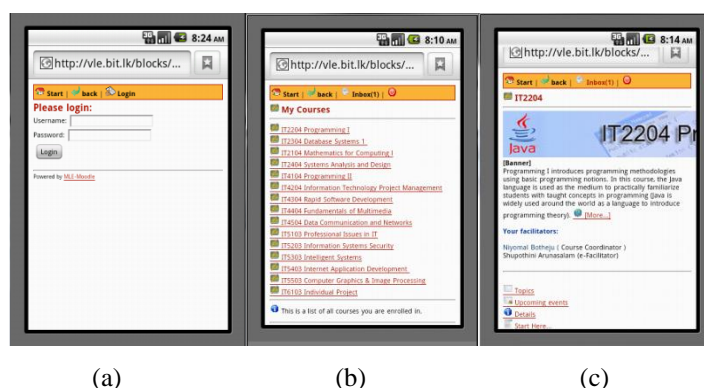
Figure 8: m-Learning Interface of Courses in the BIT VLE

Figure 8(a) shows the login page of the m-learning extension. Figure 8(b) lists the courses available when a student logins through his mobile phone. A user can navigate using buttons on the phone. When he selects the course, IT2204 Programming, Figure 8(c) shows the upper part. The student has to scroll down to see other content in the course page.

(a)   (b)   (c)
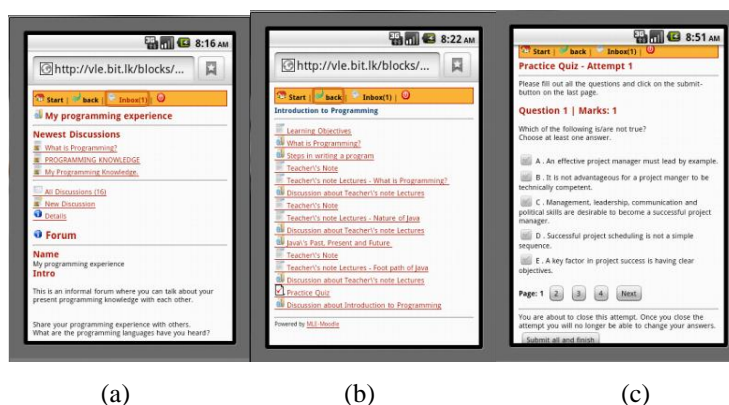
Figure 9: Learning Activities through m-Learning Interface

Figure 9(a) shows the starting page of a forum with links to navigate in threads. Figure 9(b) shows the learning resources when selected a particular topic. It only shows learning resources that can be viewed, such as textual resources, discussion forums and online quizzes. Interactive SCROM learning objects developed using flash content are not displayed since they cannot be browsed in many mobile devices. Figure 9(c) shows a MCQ quiz screen.

Courses in the Moodle VLE were designed considering online access through desktop computers. Most of the text content that was displayed on a mobile browser/ application requires several screens for navigation. Learners with Java enable mobile devices were able to browse pdf documents but many users fail to access them. The biggest

discouraging point was no support for SCORM and flash objects. Except very few users who had the latest smart phones, all other users had no option to browse interactive learning activities. Students who were used to be desktop environment didn't like the interface because of small appearance and too much content on the screen.

CONCLUSION

This paper presents the road map followed in developing an m-learning extension to the existing e-Learning framework established using Moodle based VLE. Many people believe that learning through mobile devices create the environment for m-learning. With the spread of mobile wireless broadband, accessing Internet through mobile devices has become a ubiquitous activity. However, these mobile devices have their own limitations and they cannot be used to perform all activities carried out using desktops. However, people forget these factors due to marketing propaganda with respect to mobile technology and m-learning.

Both e-learning and m-learning are ICT enabled applications through Internet. How are they related to each other? Using m-learning, can we do everything what we did using e-learning? If the development is incremental, can we develop m-learning extensions on the top of our e-learning infrastructure? What are the problems learners faced when they encounter both e-learning and m-learning? These questions can be answered theoretically using an extensive discussion. This paper describes a practical path followed to find out the answers for them as well as to experience the reality.

After carefully investigating what is technically possible using the current technology, we selected two functionalities to develop the m-learning extension. The work was carried out using Moodle based e-Learning framework at the UCSC. These two functionalities are 1) SMS integration to Moodle VLE and 2) accessing Moodle VLE via mobile devices.

Considering SMS integration, we developed two features namely, SMS Forums and SMS Polls. While experimenting them, we shared codes developed with the open source community to move forward together. Bi-directional communication between learners and the moodle VLE using SMS could improve the interaction. SMS integration to forum allows to have an SMS interface. The SMS poll messages are very important to take student feedback. Technically, this is an interesting exercise but when we evaluate these features we understood the importance of pedagogical issues in m-learning [Yeonjeong 2011].

Considering different of mobile phones, we experimented the access to Moodle VLE using two approaches, namely Mobile Browsers and a mobile application developed using MLE moodle plug-in. These two approaches have their own capabilities and limitations. Accessing learning content through mobile devices is not very comfortable. Both technical and pedagogical issues affect significantly when learners try to access existing e-learning content [Kristine 2007]. The e-Learning content was designed considering desktop interfaces. Both teachers and students who were very familiar with the existing e-learning infrastructure are unsatisfied with the facilities and interface of the m-learning extension.

The most important lesson that we learned in this study, is to consider both technical and pedagogical aspects together. M-learning extensions cannot be developed to an existing e-learning without changing the pedagogy and design of learning content. What we do in a class room environment cannot be delivered as it is in an e-learning environment. Both the pedagogy and learning content must be changed to make it suitable to deliver using an e-learning system. The same rule is applied when we want to transfer from e-learning to m-learning. When we move from one paradigm to another, we will have several new opportunities as well as we have to sacrifice some good practices in the previous paradigm.

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Short Papers

An Architecture for Device Independent Mobile Learning Content Presentation

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ABSTRACT

The concept of m-learning which differs from other forms of e-learning covers a wide range of possibilities opened up by the convergence of new mobile technologies, wireless communication structure and distance learning development. This process of converging has launched some new goals to support m-learning where heterogeneity of devices, their operating systems (Linux, Windows, Symbian, Android etc) and supported markup languages (WML, XHTML etc), adaptive content, preferences or characteristics of user have become some of the major problems to be solved. To facilitate the learning process even more and to establish literally anytime anywhere learning, learning material/content should be available to the user always even if the user is in offline. Multiple devices used by the same user should also be synchronized among themselves and with server to provide updated learning content and to give a freedom to the user to choose any device as per his/her convenience. In this paper software architecture has been proposed to solve these problems and has been implemented by using a multidimensional flashcard learning system which synchronizes among all the devices that are being used by the user.

Author Keywords

Mobile Learning, content adaptation, device independent learning, content synchronization

INTRODUCTION

Kinshuk et al. (2003) propose an appropriate definition of Mobile Learning: "m-learning is defined as the ability of using handheld devices to access learning resources"; All humans have the right to access learning materials and information to improve their quality of life regardless of where they live, their status, and their culture. Mobile learning, through the use of mobile technology, will allow citizens of the world to access learning materials and information from anywhere and at anytime. This idea will literally come true only after a worldwide successful implementation of presentation of device independent learning content. The identified barriers that have to be taken care of to support mobile learning are:

1) Various kinds of devices used by different users or in different times/parallel by the same user which is not predictable and have to be recognized by the system in order to know device capabilities (Gaedke, et al, 1998) In a stable place like at home or at office it is more convenient to use a PC. While on the move it is very obvious that a user would like to access same content with the same outlook and feel by using his mobile device. So a system is necessary which is device dependent from the point of communication functionality, interactivity, 3D capabilities, and information presentation and information depth. But at the same time it must be device independent from the point of information access, and (a-) synchronous communication possibilities. 2) The overall number of users of specialized content or interactive applications is too low to adapt the application/content to all possible devices manually. 3) Content and User Interfaces could include different kinds of data format like text, image, audio, video, 3D Virtual Reality data and upcoming other formats (Meawad, et al 2008). The system should be able to deal with all the existing and upcoming formats of data without requiring any huge enhancement. 4) The content should be always available to the user independent of the internet access possibility. Moreover in case of multiple devices, used by the same user, should be synchronized to make updated content available in all the used devices. The goal of this research work is to find a way to solve the above stated problems by investigating system architectures to provide unconstrained, continuous and personalized access to the content and interactive applications everywhere and at anytime with different devices. Especially for future UIs using media photonics

like holographic interfaces this is an outstanding issue for further research. A very suitable and useful example of the use of such a system is mobile learning because of the large amount of varying devices with significantly different features and functionalities.

IDENTIFICATION OF THE CONNECTED DEVICE

We selected WURFL for the description of the features of mobile devices and browsers because WURFL model is an XML configuration file which contains information about capabilities and features of many mobile devices in the wireless world. Also, the repository of device in WURFL is updated every day by contributors in the world. So it is an up to date specification that brings reliability in device data manipulation. Our system works with a combination of WURFL and a local database. Figure 1 below shows the whole process.

Figure 1. Process of device detection (based on Caballe et al, 2010).

First, it is detected whether the user is connecting to the system via mobile device or by desktop device by analyzing the user-agent parameter of the HTTP-header. In case of mobile devices, the local database is checked whether the device is listed and the available information is up-to-date. Outdated device information is determined using the WURFL.

ADAPTATION OF LEARNING MATERIAL AS CONTENT

W3C in W3C-MBP (2008) has categorized three approaches where the adaptation is taking place: 1) client-side, 2) server-side and 3) proxy-side. Our system is using both the server and proxy side approaches based on necessity. For example 3D data or virtual reality scene it is advantageous to use proxy based approach (Feisst, 2006 PhD thesis) Additional to the WURFL database, we used Wireless Abstraction Library from WURFL (WALL) to realize content adaptation according to the mobile device. It gives the author the possibility to mark-up his content with WALL tags that are automatically transformed to the correct tags supported by the connected device afterward, e.g., the tag *<wall :br>* is transformed into *
* for devices which uses CHTML and to *
* for WML or XHTML MP enabled devices. Another reason behind using XML based data storage for our system is it allows the author to classify their content according to the importance of the content and not according to different devices. Usually authors tend to generate their learning material for PC and laptop usage and later on strip it down to adjust the content to lower end devices like mobile phone. As a result, content may become incomprehensible and nearly unreadable. Furthermore, cutting down content may result in loss of important relationships. In our system, content, which is less important, can be omitted on lower end devices without losing the relations of the learning content because the author has to start with the essential learning content (Table 1). This information has to be presented on all devices. The additional information has to be tagged as for example level: important, relevant or optional. Indeed, the system evaluates which content class fits best to a device class, though the system does not automatically decide on the importance of the content.

LEVEL	CONTENT
Essential	This is essential part of the content
Important	This is essential part of the content. This is important part of the content
Relevant	This is essential part of the content. This is important part of the content This is relevant to the content
Optional	This is essential part of the content. This is important part of the content This is relevant to the content This is optional part of the content

Table 11. Different level of learning content

Specifying the level attribute remains the important responsibility of the author of the learning content and it has to remain like this.

AVAILABILITY OF LEARNING MATERIAL

Anytime anywhere learning could be hindered due to unavailable internet access either temporarily or permanently. Users should be able to use their devices both online and offline. Learning content should be saved on the central part of the system (Server) but partially it should also be possible on PCs or mobiles of the users. Therefore, to establish literally anytime anywhere learning the desired system must be a combination of centralized and decentralized system.

IMPLEMENTATION

The ideas, to recognize end user´s device and communicating online and offline to have learning content (in the system as content of a side of a Flashcard) available all the time were implemented in a multidimensional Flashcard learning system. A Flashcard, as defined in Wikipedia [http://en.wikipedia.org/wiki/Flashcard, [6 August 2009], is a card that is used as a learning aid and contains a question on a card and an answer overleaf. Our flashcard system would be an expansion of the basic flashcard concept. First of all the system should be useful not only for memorization but also for some other types of learning. Therefore, every card in this system can have different sides. Every side will have a definite type of content, so that a user would know which side to look for his/her desired content. For example side 1 always contains a question, side 2 contains its answer and side 3 contains an example. Furthermore, every side of our cards may contain different format of data like text, animation, audio and/or video.

System structure

The overall structure of the flashcard system is shown in figure 2. The system consists of a central part which is a server and all its components, and decentralized parts which are PCs and mobiles of either same user or different users. Therefore, the system can be used by the user without connecting to a server. During offline communication only PC and/or mobile are used. Synchronization is done to keep concurrency in such a system between both centralized and decentralized parts as soon as any of two used devices with each other or any device with server gets connected. Every user has a specified folder on the server for her/him, which is called "private folder user X" accessible only by the owner. All the users would have access to the public part of the server; therefore, subject boxes which are public and are created to be used by all the users, have to be placed in public part of the server. All the folders are containing Flashcards.
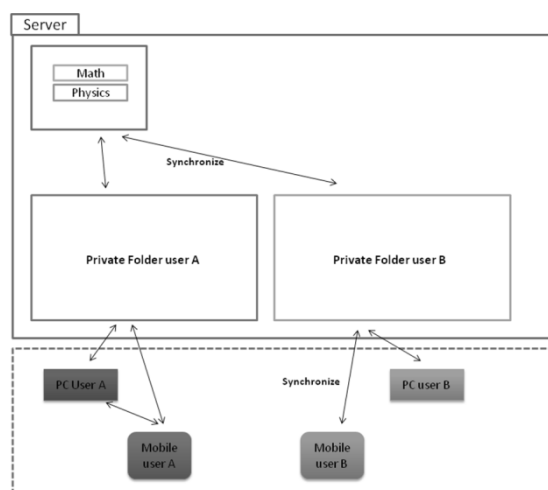
Figure 6. Overall System Structure

CONCLUSION

The aim of this project is to establish anytime anywhere learning independent of place, time, device, end user´s status and internet connectivity. To achieve this goal first step was to identify connected device to know its capabilities, second step was to prepare generalized content, then translate and transfer generalized content according to the capability of end user´s device. To make the process more realistic it was also a necessity to support different devices owned by same user and to keep learning material available even if the user wants to learn offline or wants to create learning content offline. To maintain concurrency of the system a tremendous need was the synchronization process which is taking place between centralized and decentralized part of the system. The offline communication in decentralized part is established and tested for a single user, for example user A using mobile phone, laptop and a PDA. Still offline communication among different users using different sort of devices has to be implemented and tested.

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Usability and generativity: why Android is better suited than Apple's IOS for mobile learning development in a developing world context.

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ABSTRACT

This short paper originates from the author's involvement in creating and implementing failed and successful mobile learning applications in a developing world context since 2006; specific reference is made to the notions of usability and generativity. In doing so he compares Java, IOS and Android as development platforms for mobile learning and concludes that Android should be preferred to IOS as platform for mobile learning development – especially in a developing world context where cost is important.

Author Keywords

Android, IOS, eLearning, usability, generativity

INTRODUCTION

The author has been involved in three mobile learning projects since 2006: the initial project was to deliver content to high school children via Java on feature phones; followed by another Java project in a health environment; and finally the current project which uses the Android platform to deliver a digital learning experience on tablet devices. All three of these projects have taken place in a developing African context with the numbers of active learners ranging from a few hundred to just over 2000 (cf MLearn proceedings, 2007, 2008, 2009). The paper links up with Nielsen and Hanseth's 2010 article, *Towards a design theory of usability and generativity;* investigating the relation of the two concepts and their importance for the development of new products and services, delivered at the 18th European Conference on Information Systems. In that paper, Nielsen and Hanseth argued that "both usability and generativity are important elements to understand the further evolution of mobile phones and critical for their design". The Apple iPhone was used as a prime example of a "fairly successful model in serving users and innovators" (2010:7) in contrast to feature phone models where usability and generativity are limited and Android phones where usability is problematic. This paper compares Java, IOS and Android within that same context but arrives at a rather different view regarding the "generative" nature of the IOS platform. Considering the realities of creating mobile learning applications – especially in a developing world context, it is clear that the Android platform is much more suited to serve "innovators" in the digital learning space than is the case with the IOS platform. It suggests that anyone wishing to design mobile learning applications in and for an imperfect world where digital education is fluid, where cost matters and where innovation is often flawed should probably do so in the Android environment rather than that of IOS.

A DESIGN THEORY OF USABILITY AND GENERATIVITY

Nielsen and Hanseth (2010:2) distinguish between two types of technology – those that are created with the expectation of minimal "tampering" by users (*usability* focus) and those, like for instance the Internet, that "are made for users as innovators" (*generativity*). When one looks at the mobile landscape before the introduction of the iPhone it is clear that the usage of phones for "new purposes and applications has not quite lived up to expectations" (2010:2); however all of this changed with the advent of the iPhone in June 2007 because "what Apple has managed to do is to focus on both the users and the innovators" (2010:10).

Usability

Usability is the extent to which any device, by virtue of its properties, allows for ease of use in terms of the purpose that it was created for. One of the most widely read authors in this regard is Nielsen (1993), who discusses the concept of usability along the following lines (some of which distinguish between user types): *Learnability*:

How easy is it for users to do complete basic actions when they encounter the design for the first time? *Efficiency*: Provided that users have become experts, how quickly can they perform tasks? *Memorability*: How soon can users return to proficiency if they start to use the design after not having done so for a while? *Errors*: How often do users err, what is the severity of the errors and is it easy to recover from them? *Satisfaction*: From a subjective point of view, is usage of the technology pleasant and to what degree? (1993:24-36). Nielsen and Hanseth point out that according to the prevailing wisdom in usability studies a technology that rates high on usability normally will not rate high on the innovation front and vice versa since the underlying philosophy differs quite substantially (2010:5-6). This idea is not new - it is taken over from the work of Don Norman *The Invisible Computer* (1998), where he argues that PC's have become too complex and that in time they will become more like *appliances* allowing for more dedicated use and more simplicity. Crucial to this is the fact that with simplicity limited "innovation" will arise - a CD player cannot be used for anything other than that for which it was intended. Kukulska-Hulme (2007:2-4) specifically discusses the relevance of usability in mobile learning and remarks that "…   in mobile learning, user-centered design and attention to contexts of use will lead to better mobile learning usability" (3). This, however, is obviously dependent on the device and platform in question.

Generativity
Nielsen and Hanseth's understanding of *generative technology* has its roots in the work of Lessig (2001) and David (2005) regarding the Internet as a "network where intelligence is in the fringes" (2010:5) and since it is not optimized for any specific application "but rather open for and inviting the unexpected... innovations by independent actors can flourish without changes in the underlying infrastructure" (2010:5). Lessig argued in *The Future of ideas: the fate of the commons in a connected world* that innovation and creativity which were part and parcel of the Internet at its inception were (and are) continually being eroded by *regulation (*2001:6). David similarly cautioned against the unintended consequences of regulation and control (2005). Of special importance in this regard is the concept of *generative technology*, coined by Zittrain, which has to do with the properties of technology and how it influences innovation (2008:5). Generative technology is technology that, by its very nature, encourages innovation even if it goes beyond the scope of the original intention of its creators. Elsewhere (2008:73) Zittrain puts it as follows: "Generativity is a system's capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences... Generativity pairs an input consisting of unfiltered contributions from diverse people and groups, who may or may not be working in concert, with the output of unanticipated change".

Usability, generativity and mobile design
When mobile design is evaluated from the perspective of usability and generativity it becomes fairly obvious why feature phones have so clearly fallen out of favour with both users and innovators. This is nowhere as obvious as with the rapid decline in the fortunes of Nokia, once the leading global cell phone provider; who has had no other choice than to partner with Microsoft, once one of its main rivals, and adopt Microsoft Phone as its primary mobile operating system, announced 11 February 2011. For one, feature phones cannot offer a user experience in a mobile technology world increasingly glued together by the Internet and Web 2.0 services such as Google Search, Twitter and Facebook which comes close to fulfilling the usability requirements that Nielsen has identified. Additionally Java, Symbian and other feature phone (or semi-smart phone) operating systems offer really limited scope for innovators. In comparison, the newer generation operating systems such as Android seem to represent a whole new world; one where not only users but innovators can push an array of devices to previously unthinkable exploits and uses.

USABILITY, GENERATIVITY AND MOBILE LEARNING DESIGN IN AN AFRICAN DEVELOPING WORLD CONTEXT
In the period from about June 2006 to April 2011, the author was involved in three different mobile learning initiatives, all within a developing world context. The first two instances involved working within a Java environment and feature phones and the final one working with the Android operating system on Android tablets.

Mobile learning on feature phones
Like many developing countries, South Africa has a dire need for quality Mathematics education (cf Arnott & Kubeka, 1997; Kahn, 1993; Taylor & Vinjevold, 1999; Howie, 2003). A number of mobile learning interventions have been undertaken to address this issue in the past few years cf Matthee (2007), Liebenberg (2010). An early attempt called M☺BI aimed specifically at providing high school learners with alternative Mathematics instruction, based on the Grade 10-12 South African curriculum, in the form of about 1000 mobile mathematics videos with assessments. At the time very few Java-enabled phones natively had video streaming built in. The project was therefore technically quite ambitious; it not only attempted delivering video content but did so by streaming content to phones that did not yet have the capacity to deal with video streaming. In addition, the average phone memory capacity at the time was limited which led to all sorts of problems when trying to push

content to phones so that a decision had to be made on how to deal with the size of the content. As a result videos were streamed in sections no longer than 30 seconds and by using two players simultaneously (one downloading in the background and the other streaming in front and then switching between the two) it was possible to create the illusion of continuous video streaming. Videos were degraded to about 8fps to cut down on bandwidth. The M☺BI application was not adapted specifically for each phone model instead it was written as a "one size fits all" solution. This had certain advantages in that it led to significant savings in development cost, time and resources. However, even though the application worked sufficiently enough and was, in fact, fairly advanced for what was achieved technically – especially in terms of being able to stream on phones without RTSP (Real Time Streaming) support -   the *usability* left much to be desired. Navigation was mostly cumbersome and was not always intuitive (*Learnability, Efficiency).*   The "one-size-fits-all" menu system led to issues in *memorability* and in line with Nielsen's general observations about mobiles and mobile content the devices themselves were far from ideal (2011), which combined with the video degradation did not lead to great user satisfaction. All of these were confirmed in the low retention of learners subscribed to the system.   As for *generativity* - it should be clear from the description above that this was not a situation of the Java platform so much inviting innovation as that it challenged innovation.

Open sourcing mobile learning – how the mobile learning engine (MLE) increased usability and generativity for Java devices
M☺BI 2 was built on the open source Mobile Learning Engine, or MLE, "a comprehensive learning application... which transfers computer-aided and multimedia-based learning to a mobile environment..." (MLE - Webmaster 2010). This application was utilized with great success to deliver mobile post-training support for about 2600 data capturers from the so-called 3535 HISDC project of the National Department of Health in South Africa.   As part of the training delivery it was expected of the service provider, which included the University of Pretoria, to provide post-training support to all learners. Essentially the MLE is an additional layer on top of the Java environment that contributes tremendously towards its *usability* and *generativity*. IT consists of three different software components which allow for content creation, delivery and access, detailed on the website as described below: (MLE - Webmaster 2010).
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The Mobile Client (MLE Itself)
This is the actual Java application, the end-user user-interface, which runs on the mobile phone. As this client was created device-specific it contributed immensely towards the usability of the application; in that it improved learnability, efficiency and user satisfaction.

The Gateway and Messaging Server
"These two Java servers (J2SE) are installed on a standard server with Internet access. They are used by the mobile client to access the Internet in a more efficient way and for instant messaging." (MLE - Webmaster 2010).

MLE Editor
This is a WYSIWYG (What You See Is What You Get) Editor to create content (whole content packages) for the mobile client. This might be just some formatted text with images or a whole learning-object with interactive questions. This editor was designed for people with no XML experience. The idea is to make the implementation as easy as possible for non-specialists. For the purposes of the HISDC project, a dedicated MLE server was set up and the MLE was modified and renamed M☺BI. The Gateway messaging server and the MLE Editor both contributed towards the generativity of the platform in that it allowed for easier content delivery and interactions with less knowledge than is the case with Java only.

Usability and generativity
The MLE (M☺BI 2) certainly had many advantages in relation to its predecessor. For one, it had a different version for each of about 800 popular Java devices which meant that it immediately solved many of the navigation issues present in the first M☺BI. By making use of a "tabbed" interface (see Figure 2) it provided an inherently easier navigation interface than was the case with the first M☺BI which took more of a linear approach to its menu. This immediately resulted in improved usability, particularly *learnability* and *efficiency.*   So far, during the first two phases of this project, it has enabled learners to access content thousands of times and post hundreds of questions on the FAQ section of the project. It enabled learners to create many private chat groups and also to engage with the service. That is was quite user friendly is evident by the thousands of questions posted in the FAQ section of the HISDC website through the MLE, as well as the thousands of times that content was accessed by the 2200 learners which formed part of the first two waves of the HISDC training.   Directly related to this is the fact that the MLE environment lends itself much more to generativity than is the case with the Java on its own. For this reason the implementation of things like FAQ's and user groups was quite easy to set up and maintain. It should be noted that the focus is on static text information in the form of slide presentations, FAQ's, IM, etc but not on video.

However despite these advantages, it is obvious that the MLE environment is not without its limitations. For one, it is still built upon the Java and therefore inherently shares its architecture and due to device limitations it refrains from using video content. Navigation, web access, video streaming and Internet connectivity are still constrained quite severely by it – in comparison to what is possible by so-called smart phone operating systems such as IOS and Android. Both from a usability and generativity perspective it still leaves much to be desired – despite being quite successful for delivering post-training support. For instance – it only allows limited access to device functions such as the camera.

ANDROID, IOS AND MOBILE LEARNING IN A "DEVELOPING WORLD" CONTEXT

When Steve Jobs announced the IPhone in 2007 it changed not only the mobile landscape but also how users engage with the Internet through mobiles - forever. Some (like Nokia, cf Levis, 2009) failed to realize that this signaled the end of feature phones, while others with a big vested interest in the Internet - like Google, who had already acquired Android in 2005 and had retained the original founders to keep working on it, released its first version in November 2007 (Roth, 2008) together with the Open Handset Alliance. For anyone in the mobile learning space the advent of a smart phone platform that allowed for the creation of own applications to the extent that the iPhone did signaled a new era and for the M☺BI developers this was no different. IOS almost immediately had huge traction internationally and applications available quickly rose to thousands; so it represented an attractive option. Indeed, for Nielsen and Hanseth, the iPhone is the ultimate mix of usability and generativity. "What Apple has managed to do is to focus on both the users and the innovators. … Rather than offering their own applications only, they offer a platform open for users and innovators to interact." (2010:11); from their perspective IOS had everything users and innovators needed.   This is, however, in stark contrast to the view of Zittrain (2008:5) who does not agree that the IOS platform is open. Instead, in his discussion of generative technology he uses two Apple products to illustrate his point: The first is the Apple II which appeared about 30 years before the iPhone. Whereas the former was generative, the latter is "sterile" and rather than "a platform which invites innovation, the iPhone comes preprogrammed... it was not to be generative beyond the innovations that Apple... wanted" (2008:5).

This same view was also shared by the M☺BI developers although their decision to ultimately embrace Android rather than that of Apple, when it had to choose a smart phone platform, admittedly had very little to do with an academic consideration of *usability* and *generativity*. Still, the issues that feature in this debate did actually play a role and in fact generativity probably played a bigger role than usability in their final decision. Indeed, the IOS operating system closely tied with the iPhone (and later iPad) hardware had everything going for it in terms of attractiveness, polished design and a great SDK. But in order to use it in a developing world context there was simply no choice – it was the iPhone/iPad hardware or nothing else. In addition, within the IOS universe, applications are obtainable only through iTunes. These two issues, more than anything else limits Apple severely in terms of generativity. Contrast this to the Android universe where there is no device lock in and where delivery through the marketplace is entirely optional. In addition, the Android software can be customized from the image file upwards, including boot image, background etc. What is more, in a world where a vast amount of eLearning content exists in Flash, the promise of Android running Flash from 2.2 onwards is enticing. These factors combined means that Android invites and allows much more generativity than the Apple platform. As a case in point, the current version of the M☺BIPad which is currently piloted as part of the Ericsson Connect to Learn project in South Africa has a customized image file, including background and boot images, comes preloaded with M☺BI software (Maths, Reading, Spelling, etc), and it allows for iterative design, local updates and testing on a scale not possible with IOS. Also, it is possible to do testing on a variety of devices, ranging from Android phones, to tablets with resistive screens, to ones with only WIFI connectivity or with 3G built in. Of course this does not mean that the Android platform is without its problems. The issue of fragmentation in the Android universe has been noted by many commentators (Grundstrom, 2010), as is the fact that it is not quite as accomplished in terms of usability as the iPhone and iPad. However in the context of mobile learning the ultimate question is not how something stacks up against IOS but rather whether it allows one to deliver a good enough product that does what it is supposed to do and in this regard Android is the perfect platform.

CONCLUSIONS

The notions of *usability* and *generativity* have proven useful to try and explain some of the successes and failures of mobile learning development and implementation in which the author has been involved with in the past few years. Ultimately the goal of developing a mobile learning application is not whether it will be the best smart phone application ever, but rather whether it is good enough to deliver a technology enhanced learning experience that meets the needs of educators and learners within a particular context. Within a developing South African context, Android not only provides for an affordable solution, but it also allows for levels of experimentation and iteration which is simply not feasible and practical within an IOS environment – something which is directly linked to the notion of *generativity*. For this reason it is strongly recommended that anyone wishing to develop rich mobile learning applications within a developing world context uses Android rather than IOS. This is not an

ideological decision but rather a practical one and it is clear that what Android may lack in terms of *usability* or perceived usability in comparison with IOS, it more than compensates for in terms of *generativity.*

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TOPIC 4: ubiquitous and ambient learning and technology

Long Papers

Leveraging Ubiquitous Technology for Seamless Language Learning: From "Move, Idioms!" to MyCLOUD

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ABSTRACT

Paralleling to the paradigm shift in language learning theories from behaviorism to a communicative and authentic learning approach, the focus of Mobile-Assisted Language Learning (MALL) is swinging to design-oriented authentic or social mobile learning activities. In a related note, the ready-to-hand access of mobile devices creates the potential for facilitating 'seamless learning spaces', marked by continuity of the learning experience across different contexts. In this paper, we propose perspectives and approaches to address the need of establishing seamless language learning (SLL) practice. Building on existing research work on MALL, the emerging approach highlights a theory-rooted socio-techno-pedagogical framework to address the challenges of the young language learners. We will describe how the notion of SLL informs a research study entitled MyCLOUD (My Chinese Language ubiquitOUs learning Days). The proposed framework could contribute to current research by exploring ways in closing the loops in both the seamless learning and language learning perspectives through enacting the on-going learning process mediated by the ubiquitous technology.

Author Keywords

Mobile-assisted language learning (MALL), seamless learning, vocabulary learning, socio-techno-pedagogical framework, design for scalability

INTRODUCTION

Learners from the Generation-Y live in a world where there is constant interplay between the physical and digital realms, and the use of technologies such as blogging, social networking and digital content remixing are integrated into their lifestyles (Looi, et al., 2010). The proliferation of Web 2.0 supported by cloud computing technologies has prompted researchers and educators to look into ways to leverage learners' enthusiasms in the use of technologies to extend their learning beyond the four walls of the classroom. Furthermore, the ready-to-hand access of mobile devices, which could function as a personal 'learning hub' (Looi, et al., 2009), creates the potential for a new wave of evolution of technology-enhanced learning (TEL) that is characterized by 'seamless learning spaces' (Chan, et al., 2006; Wong & Looi, 2011; Wong, in-press). Such spaces are marked by continuity of the learning experience across different environments. Individual learner who has 24x7 ubiquitous access to *at least* one mobile device (1:1) would have plenty opportunities to traverse the formal and informal contexts, physical world and cyberspace, as well as personal and social learning spaces.

In a related note, paralleling to the paradigm shift in language learning theories from behaviorism to a communicative and authentic learning approach, the focus of Mobile-Assisted Language Learning (MALL) is swinging from content-based delivery of relatively static learning content through mobile devices to design-oriented authentic or social mobile learning activities (Kukulska-Hulme & Shield, 2007). Such a trend can make MALL a viable solution to blending learners' language learning environment into their daily life (Wong & Looi, 2010).

In this paper, we propose perspectives and approaches to address the need of establishing *seamless language learning* (SLL) practice. The proposed approach is grounded in the theories pertaining to language learning and TEL. Building on existing research work on MALL, the emerging approach highlight a socio-techno-pedagogical framework to address the challenges of Singapore ethnic Chinese children's (who tend to be more well-versed in English) learning of Chinese as second language (L2). We will describe how the notion of SLL informs a prospective research study entitled MyCLOUD (My Chinese Language ubiquitOUs learning Days). The proposed

framework could contribute to current research by exploring ways in closing the loops in both the seamless learning perspective and the language learning perspective through the on-going learning process mediated by the ubiquitous technology. Matching the affordances of ubiquitous technology to these perspectives would enhance the development of 21st century knowledge and skills and nurture holistic language competencies among learners.

THE RATIONALE OF SEAMLESS LANGUAGE LEARNING

One of the critical problems in traditional L2 classroom practices is the excessive amount of decontextualized information, indirect and abstract language knowledge, and 'secondhand' experiences confined in classroom context (e.g., Jiang, 2000). Therefore, language learning theorists have been advocating the integration of formal and informal language learning (e.g., Titone, 1969). The integration implies greater learner autonomy in language learning, which is again a notable trend in both modern language learning research and practice.

Personalized mobile devices can become a learner's 'learning hub' that facilitates and supports learner involvement, learner reflection and target language use across different learning spaces. Such 1:1 TEL model has great potential in facilitating a significant reform in language learning. Nevertheless, the potential has yet to be thoroughly explored or exploited by MALL researchers. Almost all the MALL studies to date have been heavily focusing on either formal learning (Wong, Boticki, Sun, & Looi, 2011; Zurita & Nussbaum, 2004) or informal learning (Fallahkhair, Pemberton, & Griffith, 2007; Song & Fox, 2008). The integration of both seems rare.

We envisage an ongoing SLL model to address the research gap. With proper learning design, the mobile and ubiquitous technologies could facilitate the transformation of classroom learning activities into a more personalized and social learning process. Learners engaged in such a learning experience need to process and associate their experiences or the situated information received (informal contexts) with the knowledge that they have acquired or constructed in the classroom, and apply the knowledge in daily life. In the context of language learning, it is to apply their language knowledge for communication, articulation of thoughts, or production of linguistic artifacts such as essays, tweets on social networks or blog entries. Eventually, it is desirable to feed the learners' situated learning gains back to the formal class for generalization, thus completing a seamless learning cycle.

THE FOCUS ON VOCABULARY LEARNING – THE STUDY OF "MOVE, IDIOMS!"

Vocabulary acquisition has a central role in learning a L2 (Sokmen, 1997). One important claim is that a good knowledge of how the system of language works (grammar), may not necessarily enable one to communicate; however, it is usually possible to communicate if one has sufficient vocabulary (Wallace, 1988). Ellis (2002) posits that early L2 learning should be focused on vocabulary, and that grammatical instruction comes after learners are able to engage in message-focused tasks using whatever language they have regardless of grammatical correctness.

However, Schmitt (2008) observes that many L2 teachers (as well as many vocabulary-focused MALL studies, e.g., Chen & Chung, 2007; Levy & Kennedy, 2005) have been emphasizing rote learning of large quantity of vocabularies, and consider a word 'learnt' if the form and meaning are known. Contrarily, Nation (2001) highlights the necessity of the inclusion of contextualized components of vocabulary knowledge, such as grammatical functions, collocations and constraints on use. Therefore, while the form-meaning link is crucial for vocabulary acquisition, learners ought to advance to contextualized exposures (listening and reading) and productive use (speaking and writing) of vocabulary, perhaps in authentic situations, which is what another smaller set of MALL studies had investigated (e.g., Fallahkhair, et al., 2007; Ogata, et al., 2008). Nevertheless, to close the loop, the learners need to proceed for decontextualization (generalization) of vocabulary knowledge (Schmitt, 2008) through personal reflections or social meaning negotiation. Hence, a seamless cycle of language learning should involve both contextualized understanding and contextualized use of the vocabulary, supported with the effort to generalize the word meanings, perhaps across both formal and informal settings. The mobile and Web 2.0 technologies offer many affordances to support the cycle of learning.

We conducted an intervention study on SLL entitled "Move, Idioms!" from February to November 2010. In learning Chinese idioms and conjunctions (two special forms of vocabulary), students were provided with smart-phones on a 1:1, 24x7 basis. They were encouraged to make sense of what they learn in class by capturing photos of the real-life contexts pertaining to the idioms/conjunctions, and to construct sentences with them. Subsequently, in-class or online (wiki) sharing and discussions on the contexts took place to enhance the students' understanding of the proper usage of the vocabulary. The multiple sentences constructed by the students then form a basis for the inductive reasoning that allowed students to construct generalizable meanings of the vocabulary. We co-constructed a cyclic learning process for "Move, Idioms!" with the teachers involved to guide the on-going learning experience design and refinement (see Figure 1).

The processes of the four activities are described below:

Activity 1 – In-class or on-campus contextual vocabulary learning (formal setting; physical and social learning space): The activity is aimed for motivating and preparing students to engage in subsequent after-school activities. During each lesson, multimedia presentations of a few vocabularies are shown in the class to assist the students in establishing the initial form-meaning link. The teacher then conducts contextualized collaborative learning activities such as facilitating student groups to take photos and make sentences on campus to illustrate the idioms/conjunctions.

Activity 2 – Out-of-class, contextual, independent sentence making (informal setting; physical, individual and productive learning space): Students carry their smart-phones 24x7. They identify or discover contexts in their daily life that are associated with the idioms/conjunctions. They then take photos, make sentences by using the vocabulary as photo captions, and post them onto a class wiki. In the wiki, we create one page for each vocabulary for students to post their work. This allows comparison of student-identified contexts and their sentences pertaining to the same vocabulary.

Activity 3 – Out-of-class, online peer learning (informal setting; cyber- and social learning space): Students learn from and perform peer reviews on the wiki by commenting on (with the wiki comment tool), correcting or improving their peers' sentences (by modifying the sentences posted on the wiki pages). They may use PC's or laptops in school or at home to access to the wiki space.
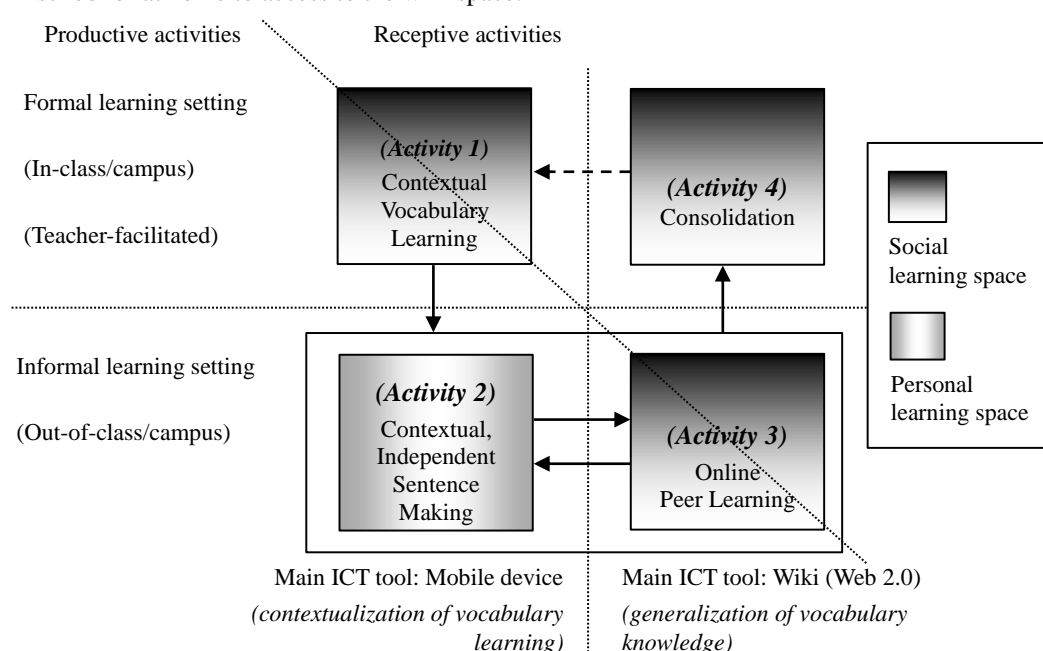
Figure 1. The mobile-assisted idiom learning process.

Activity 4 – In-class consolidation (formal setting; social and receptive learning space): The teacher facilitates class-wide or small group discussions on selected sentences made by the students on debatable contextual use of specific idioms/conjunctions.

We conducted a nine-month intervention study in 2010 with 34 Chinese Singaporean students with diverse proficiencies of the Chinese Language from a Primary 5 (11-year-old) class. Each of them was assigned a Samsung Omnia II smartphone running MS Windows Mobile[TM] 6.5 and with functions such as built-in digital camera, Wi-Fi access, Internet browser and English/Chinese text input. Furthermore, we used xwiki (www.xwiki.org) to create the wiki space for photo/sentence sharing and peer reviews. The teacher conducted numerous cycles of "Move, Idioms!" learning process.

The study yielded promising results. Due to the space constraint, we will only provide summarised findings in subsequent text. More details are given in Wong, Chin, Tan & Liu (2010) and Wong, Chen & Jan (in-press).

During the study, the students contributed a total of 920 photo/sentence sets. We found the students' photo/sentence production and commentary activities analogous to photo-blogging in general sense and yet strongly linking to the SLL process facilitated by the teacher. We categorized the student artifacts and their self-reported creation processes into three dimensions, namely, 'types of physical setting', 'types of meaning making', and 'types of cognitive process in artifact creation'. With that, we observed a similar pattern, across most of the students, of language improvement and their more eager interactions with the physical environment in their daily life. This can be attributed to the process of personal meaning making. Table 1 depicts the categorizations of

the student artifacts with an example given under each category. The original idioms are underlined in the students' Chinese sentences. To benefit international readers, we translated the sentences into English with the translations of the idioms underlined.

In addition, the students' online and in-class peer reviews have further enhanced both their understandings in individual idioms/conjunctions and their socio-cognitive skills. Through the student interviews, we have also found out that the learning activities have stimulated more family member interactions and intergenerational/sibling learning– some students worked with their family members to create the digital artifacts, such as brainstorming for photo ideas, or enlisting family members as photo models. All these are indicators of social meaning making.

FROM "MOVE, IDIOMS!" TO MYCLOUD – TOWARDS A SCALABLE SLL ENVIRONMENT

Despite the encouraging outcomes, there are challenges in terms of the scalability and sustainability of the project. The learning design may be seen as an add-on in relation to the formal Chinese Language curriculum, i.e., it is nice-to-have but too resource-consuming to implement in an on-going basis. Furthermore, in terms of language learning, idioms and conjunctions constitute a limited and highly context-specific aspect of language learning. A good contextual knowledge of the relatively small set of idioms (48 idioms were covered in the study) may enrich the students' oral and written expressions. However, the effects on the students' overall language proficiency are restricted.

Studies in psycholinguistics may shed light on the limitation of "Move, Idioms!" (and almost all other prior MALL studies) in this aspect. Psycholinguists believe that an individual stores vocabulary of a language in the form of mental lexicon. However, the mental lexicon differs radically from a dictionary as it does not store lexical items in an alphabetical order (Müller, 2008).

Types of physical settings *(photo context)*			
Natural setting	Object manipulation	Human enacted scenario	Previously published materials (e.g., Internet images, book illustrations; TV snapshots)
同学们三五成群的坐着听老师讲体育课的游戏规则。 The students are sitting in groups of three and four and listening to the briefing of the game rules in the PE class.	成群结队的动物们正在无忧无虑的吃草。 The animals come in droves and eat the grass in a carefree manner.	他们争先恐后地挤出门。 They are racing out the door.	看到这个情景，我们惊得且瞠口呆。 We are dumbstruck seeing this.
Types of meaning making *(relationship between photo and sentence contents)*			
Literal meaning making (The sentence is a direct description or interpretation of the photo context.)	Extended meaning making (The sentence is a logically deductive interpretation on the photo context.)		Creative meaning making (The sentence is a twisted, perhaps creative or metaphorical re-interpretation on the photo context.)
移民厅最近人山人海，因为学校假期要到了，很多人都忙着准备护照出国。 The immigration department is crowded as the school holiday is around the corner and many people are busy preparing (applying) passports to go abroad.	我表弟非常喜欢海绵宝宝，因为它眉开眼笑时，很可爱。 My cousin is very fond of SpongeBob as he looks so cute when smiling ear to ear.		大家都异口同声地认为牛奶含有钙致对我们的骨骼有帮助。 We all unanimously agree that milk contains calcium and is good for our bones.
Types of cognitive process in artifact creation			
With an idiom/conjunction in mind → object finding/manipulation or scenario	Object/human/scenario encountering → associating with an idiom/conjunction		Object encountering/manipulation or scenario encountering/enactment →

enactment → photo taking	(immediate retrieval) → photo taking	photo taking → associating with an idiom/conjunction (delayed retrieval)
香蕉也会眉开眼笑！哈哈哈！ Even banana grins ear to ear! Ha Ha Ha!	这些表演者不能说话，只可以做指手画脚的动作。 The performers can't talk but can only gesticulate.	游客们都千里迢迢来观赏新加坡的摩观景轮。他们一边观赏一望无际的美景，一边对新加坡的美景赞不绝口。 Tourists come from far off distances to visit Singapore Flyer. They were watching and raving about the vast stretch of beautiful scenery.

Table 1. Categorizations and examples of student artifacts in "Move, Idioms!"

To understand how L2 mental lexicon is represented as a whole, it is important to make a distinction between episodic and semantic memory (Tulving, 1983). Episodic memory receives and stores information about episodes or events. Semantic memory, conversely, functions like a mental thesaurus. It organizes knowledge one possesses about verbal symbols, their meaning and referents, and the relations among them. In word recognition studies, a similar distinction has been made between the lexical system (mental lexicon), and the non-lexical, episodic system (Forster, 1985). Within the mental lexicon, words coexist in a semantic network. In general, there exist two general lexical relations in the lexicon: the syntagmatic (collocation) relation and the paradigmatic (hyponymy, hierarchies, antonymy and synonymy) relation (Aitchison, 2003). The mental lexicon of a person is dynamic – new words acquired should be integrated to the network, which is analogous to the constructivist view of linking prior and new knowledge. If a learner encounters or rote-learns a word without a deep understanding of both its meaning and contextual usage, it may become a word in the episodic system (Jiang, 2000). In turn, we argue that a truly holistic L2 vocabulary learning process should involve the interplay of contextualized learning of individual L2 words and the construction of personal L2 mental lexicon. There had been studies in language instructions where a variety of mental lexicon-related approaches were developed, such as semantic mapping, word associations, finding substitutes, etc. (Sokmen, 1997), but other researchers argued the inadequacy of such strategies for skipping the contextualization stage (e.g., Gu & Johnson, 1996).

To address the limitations of the "Move idiom" project and to combat Singapore students' problems in Chinese Language learning (Wong, Chai & Gao, 2011; Wong, Chen, Chai, Chin & Gao, in-press), we explore a new vocabulary learning model, namely, MyCLOUD, by mobilizing the formal Chinese Language curriculum across three levels (Primary 3 to 5, or 3rd-5th grade). MyCLOUD supports cross-context seamless learning process (arose from "Move, Idioms!") and other practices informed by language acquisition theories (e.g., mental lexicon). Through the "Move, Idioms!" study, we gained a good understanding in how to facilitate SLL experiences and what is the potential of such a learning model. Our next move is to build on this learning model to address the research gap in interventions that are genuinely informed by language learning theories, an aspect that is often ignored by prior MALL studies (Wong & Looi, 2010).

MYCLOUD – THE RESEARCH PROCESS AND PLATFORM DEVELOPMENT

In the MyCLOUD project, we intend to iteratively design, implement, evaluate and refine a ubiquitous seamless learning environment for Chinese learning that is both integrated into the formal lessons and promoting students' autonomous informal learning. As the national curriculum of Chinese Language embroils a series of textbook passages associated with various learning goals, including vocabulary learning, the vocabulary-focused learning process of MyCLOUD will take the lexical items of the passages as the starting point of each learning cycle (refer to Figure 1). However, instead of prescribing a learning model developed solely by us, we will facilitate dialogues between research and practice by proposing a high-level socio-techno-pedagogical design framework. A researcher-teacher taskforce will co-design and refine the concrete pedagogy in on-going basis, where teachers' practical experiences will be respected. We adopt this approach to ease the settling of the learning model into the school ecology (see: Wong, Gao, Chai, & Chin, 2011).

As depicted in Figure 2, our proposed high-level design framework synthesizes two theoretical perspectives, namely, the language learning perspective and the seamless learning perspective. To incorporate the language learning perspective, we examine how relevant linguistic and language learning theories such as mental lexicon, contextualized learning, incidental vocabulary learning, inductive learning, productive learning, etc., can be integrated into the learning design. We consider how vocabulary learning can serve as a starting point that leads to

learning and/or enhancement of other aspects of the linguistic skills – grammar, oral, reading, writing, etc. The iterative process starts with vocabulary contextualization through situated learning (e.g., Nation, 2001), followed by decontextualization through personal reflection and social meaning making (e.g., Long, 1980), and finally the construction of mental lexicon (e.g., Hall, 1992). In a nutshell, it is a bottom-up process in building a learner's mental lexicon.
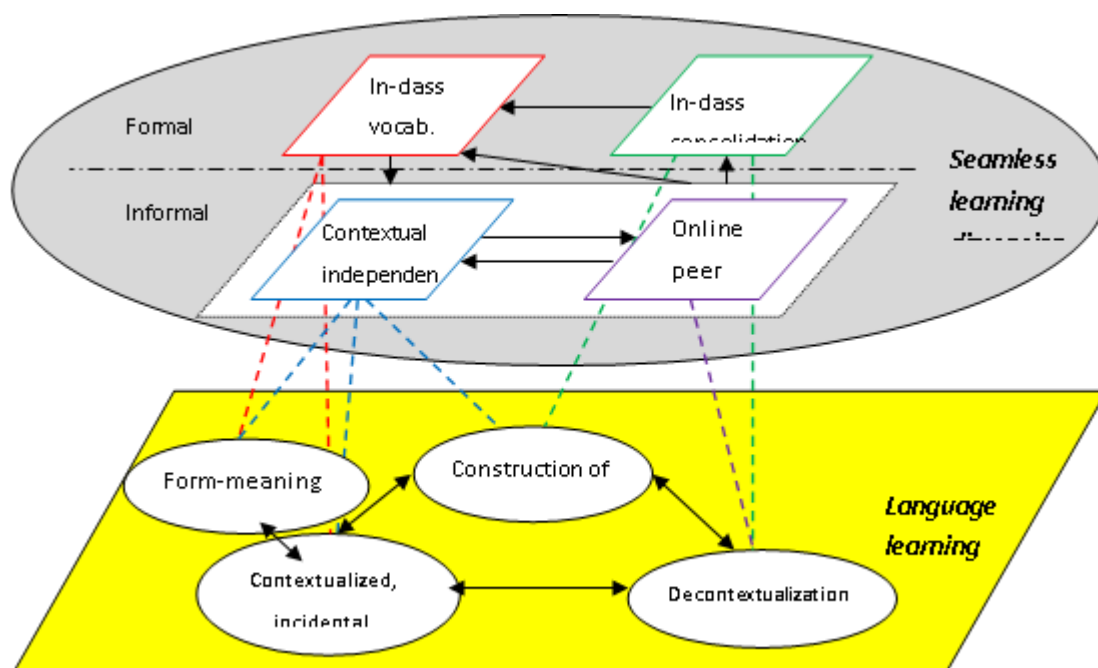
Figure 2: The socio-techno-pedagogical framework for MyCLOUD learning design

In the seamless learning dimension, we seek to refine the SLL processes that we previously developed for "Move, Idioms!" (see Figure 1). We do not prescribe the details of the process as it will be up to the taskforce to design the actual activities. For example, for the "contextual independent learning" activity, it was referred to student artifact creation in "Move, Idioms!". In MyCLOUD, we may retain this effective learning activity while incorporating additional ubiquitous learning activity types to further enhance student learning. Conversely, for "vocabulary learning" in formal setting, we might explore alternative activity models such as off-campus (perhaps context-aware) mobile learning field trips.

In Figure 2, the dashed lines between the two dimensions refer to the possible mappings between the seamless learning activities and the language learning activities – for example, "construction of mental lexicon" could take place during "contextual independent learning" (construction of students' personal mental lexicon) and "in-class consolidation" (group mental lexicon) respectively. These mappings are again not prescriptions but rather references for future learning co-design. Furthermore, the bi-directional arrows signify that the three-step vocabulary learning process is iterative and intertwining (i.e., not in fixed sequence). Nevertheless, we acknowledge that such a cognitively and disciplinarily demanding learning process is a tall order for average primary school kids. That is also one of the reasons that we set the intervention period to be three years in three experimental classes. Instead of overwhelming them with all the learning activities stated in Figure 2 from Day One, we intend to gradually introduce various learning activities and emphasise them at different stages, in order to progressively foster autonomous learning with ubiquitous technology among the students. In Year 1 (Primary 3), we will focus on contextualized learning (e.g., photo taking and sentence making to describe their daily life) and simple social networking activities (see below), plus relatively 'casual' discussions on their peers' artifacts. In Year 2 (Primary 4), with the contextualized learning activities still going on (where they will start to write paragraphs containing not one but multiple "target vocabularies" to describe the photos that they take), we will foster more meaningful, inductive peer reviews among the students. They will also deepen their learning through the construction of simple personal mental lexicons. Finally, in Year 3 (Primary 5): While the contextualized learning activities are still going on, we will elevate them to construct more complex personal and group mental lexicons.

The main mobile device that we will provide to the students in the three experimental classes in 1:1, 24x7 basis will be tablets, where they can carry out most of the MyCLOUD activities across different learning contexts. In addition, they may either make use of their personal digital cameras or camera phones, or occasionally sign out smart-phones from the school. These lightweight devices will become supplementary tools for their spontaneous

photo taking activities in their daily lives and perhaps having quicker and more convenient access to My Mictionary or tweeting (see below).

Informed by the prospective researcher-teacher co-designed MyCLOUD learning model, we will proceed to develop the MyCLOUD platform that leverages on ubiquitous and cloud computing technologies to mediate students' SLL activities. The entire system will consist of student module and teacher module.

The central component of the student module will be *My Mictionary* (My Mobile/Mental dictionary), a cloud-based personalized dictionary. Starting with an "empty" dictionary, My Mictionary can serve as an individual student's vocabulary learning e-portfolio for her to add vocabularies that she learn either intentionally (e.g., in-class, in the digitized passages on the platform) or incidentally (unfamiliar vocabularies encountered by the students in daily life), anytime, anywhere. When a new vocabulary is added, the system will automatically extract its definition and example sentences from an online Chinese-Chinese and Chinese-English dictionary, and incorporate the vocabulary into the "vocabulary page" (lexicon entry) in the My Mictionary. The student can then continue to build the content of each "vocabulary page" by pooling relevant Internet resources (e.g., webpages, online photos or YouTube videos) and upload her own photos with accompanied sentences/paragraphs (similar to the approach of "Move, Idioms!"). My Mictionary may also serve as the basis for the students to construct their personal or group *mental lexicon* (with additional MyCLOUD affordances for semantic map creation; with each node in the map representing a vocabulary linking to its corresponding lexical entry). Furthermore, a wiki-like *CoMictionary* (Community Mictionary) will be developed for students to share and peer-review their artifacts (similar to the wiki space in "Move, Idioms!"). We will also incorporate essay writing tools into the platform so that students can make use of My Mictionary to support their writing.

In addition, as we discovered most of the Primary 3 children's express tremendous interest in social networking with their peers (albeit almost always in English) through our pre-intervention surveys with the potential target students, we decided to incorporate some social networking functionality such as tweets and chats to the platform. When a student adds an Internet resource or uploads a photo/sentence set to her My Mictionary, the hyperlink to the new content will also be displayed on the social networking space, along with the student's other 'casual' tweets. Our intention is to give each student a highly personalized space so that the students would not perceive MyCLOUD as an extension of the formal curriculum but rather a space where they can 'seamlessly' bring together casual socialising and language learning. With such functionality, students will be encouraged to use Chinese in social networking.

In the teacher module, the platform can also serve as a Learning Management System for the teachers to regulate and support student learning. As the MyCLOUD learning model will involve pedagogical revamp of regular Chinese classes (not just an add-on learning activity to the formal curriculum), a user interface for lesson orchestration will be made available to the teachers for planning and managing the pedagogical processes in regular lessons. A variety of features will be incorporated, ranging from locking and unlocking selected or all platform features on in-class students' devices, the classroom response system, to monitoring of MyCLOUD platform-supported small-group learning activities.

RESEARCH METHODOLOGICAL ISSUES FOR SLL
a core issue in mobile-assisted SLL research is to collect and analyze data pertaining to both the seamless learning and language learning dimensions in order to understand how the students' learning behaviors, the technology, and the theory-informed pedagogy interplay and lead to actual learning outcomes. In the seamless learning dimension, due to the perpetual and cross-context nature of students' learning process, a variety of data collection and analysis methods should be employed, such as ethnographic methods, in-situ self-reporting, on-going questionnaires and interviews, server logging, and constant comparisons of these data sources.

In the language learning dimension, we intend to trace and analyze the full, recursive trajectory of students' initial form-meaning linking (i.e., in-class vocabulary learning), individual contextualized learning process (i.e., content creation in My Mictionary, interactions within the social networking space), social decontextualized learning process (e.g., peer reviews in CoMictionary and in-class consolidation), and the construction of the mental lexicons. Students' cognitive processes in artifact (photo/sentence sets) creation and peer reviews will be captured and examined. In addition, a corpus analysis tool will be integrated into the MyCLOUD platform to track individual students' vocabulary usage in the tweets, sentences and essays that they compose within the platform. These data will be analyzed through the lens of Second Language Acquisition theories. In addition, we will study how these productive and constructivist language learning activities may become a means of on-going formative assessment on the students.

Furthermore, there are important considerations for the technological aspect of SLL. Instead of positioning this aspect as a separate dimension in our framework, we lump it into the seamless learning dimension. The rationale is that whereas our SLL process design has been surrounding the use of tablets as 'learning hubs', we would strive for pedagogy-informed, rather than technical-driven, design for learning activities and the platform. The learning

and platform design is not meant to replace paper and pen or formal lessons, but rather to support the students in extending their learning to their daily life. With the concern of the rapid obsolescence of mobile device models, we will develop the MyCLOUD platform to be device-independent in order to ensure sustainability of the learning model. A mobile client will also be developed for students to access to the platform with personal smart-phones.

In view of the complex interplay between the students' learning experiences, the technology and pedagogy involved, we adopt Design-based research (DBR) methodology (Brown, 1992) to conduct our research. This method stresses upon systematic study on the interdependence of design elements, and the importance of examining emerging issues through progressive, iterative refining processes. It allows us to collect and analyze rich data to bear on the many simultaneously interacting factors that shapes the learning we envisage. This will help to improve the design and shape the development of the technology and the pedagogy (Design-Based Research Collective, 2003).

CONCLUSIONS

We have examined the trend of modern language learning theories and found them congruent with the general learning philosophy of the 21st century, such as seamless learning, that advocates the nurturing of learners who can positively direct their learning and collaborate with others. The ubiquitous and cloud computing technologies may mediate and support assimilation of learning into the learners' daily life. Nevertheless, instead of solely leveraging general, domain-independent learning notions such as situated cognition or socio-constructivism to guide our SLL design, it is equally important to incorporate subject matter-specific learning theories in developing learning models that would provide concrete methodology to ensure deep learning of relevant knowledge and skills. A common limitation of prior vocabulary-focused MALL studies is that they rarely go beyond behaviorist or contextualized learning. Our proposed SLL framework aims to address this limitation. Informed by psycholinguistics, we recognize the importance of facilitating learners in constructing their mental lexicon, especially for L2 learning. We therefore incorporate mental lexicon-related learning activities to assist the learners in synthesizing their vocabulary learning, as well as address the limitation of similar prior learning design of ignoring the contextualized stage by exploiting the affordances of ubiquitous technology. Indeed, our SLL framework emphasizes closing the loops in both the seamless learning dimension (to foster 21st century knowledge and skills) and the domain-specific language learning dimension (to nurture holistic language competencies) through the on-going learning process mediated by the ubiquitous technology.

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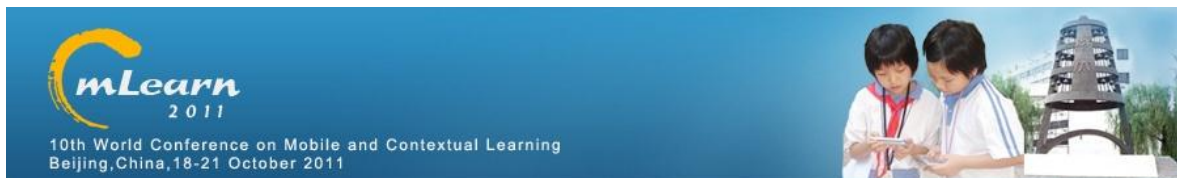
The Future Role of HTML5 in Mobile Situated Learning Scenarios

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ABSTRACT

Today usually every student owns a reasonably powerful mobile device that allows to be integrated in mobile learning scenarios. One of the drawbacks of the fast evolution of reasonably powerful devices, is the heterogeneity of that these kind of devices usually bring with them. This paper provides an overview how rich mobile learning scenarios can be implemented platform independent on the basis of HTML5 and JavaScript. The paper presents a mobile learning application based on the principles of Situated Learning entirely developed in HTML5. The paper also presents the results of tests performed with the application which were aimed at finding out the difference in performance users perceived when compared with the native desktop version of the application and the added value that mobility introduces in learning activities.

Author Keywords

HTML5, JavaScript, Situated Learning.

INTRODUCTION

As described by (M. Sharples et al., 2005), one of the major advantages of mobile learning scenarios is that the students are no longer bound to the classroom. Still a few years ago, one of the major questions dealing with mobile learning scenarios was how to be able to provide a mobile device to each learner. Nowadays, the learners usually own reasonably powerful devices themselves. Therefore, the challenge today is more to integrate the mobile devices owned by the student in well-designed learning scenarios. Unfortunately, these devices are not at all standardized. They usually are of various like usual laptops, mobile phones, tablet PCs, advanced MP3 players, using different operative systems thus providing very few possibilities of integration.

As already described by (Feist et al., 2005), these various devices implement different human-computer interaction mechanisms and use different data formats. Additionally, a major challenge in this scenario is providing applications that run on a number of different operating systems for mobile devices. As an answer to this challenge, we argue that the best strategy should be to implement platform independent applications.

This paper starts by presenting an overview of currently prominent mobile operating systems. Afterwards we present some ideas about how to implement HTML5-based applications supporting mobile learning scenarios. This section also describes some problems associated to this approach and how they can be solved. As a proof of concepts, the second part of this paper present an already running application based on this technology supporting a mobile learning scenario designed and developed based on the Situated Learning theory. Testings revealed that despite the application was not developed in a native language its usability was fair good enough. They also revealed that the learning activity was perceived as a good help to learn the concepts they are supposed to acquire during the course.

CHALLENGES IN TODAY'S MOBILE LEARNING SCENARIOS

Today, we are facing several challenges when we try to bring learning scenarios to mobile devices. As described in (G.Avellis et al, 2003) some of the challenges might be solved by an architectural approach allowing the flexible adaption of different representations of the same data. With such an approach several problems like different screens size, different interaction mechanisms and computational power can be tackled in a satisfactory way.

Another major challenge from a technical point of view in today's mobile learning scenarios is the heterogeneity of the mobile operating system platforms. At least there are five big players currently in the market: iOS, Android, Symbian, WindowsMobile and Blackberry. All of these provide rich Integrated Development Platforms that allow for the development of platform specific applications.

According to Gartner (B. Tudor et al, 2010) the distribution by vendor of the different mobile operating systems in the 3rd quarter of 2010 was the following: the most widely spread mobile operating system is the Symbian (36.6%) system usually deployed on mobile phones from Nokia. Android (25.5%) as Googles operating system for mobile placed second. Apples iOS (16.7%) and Blackberry (14.8%) are pretty much heads up placed on 3rd and 4th position. Some potential might still be by the 5th placed WindowsMobile (2.8%) operating system from Microsoft. Here it is said that most probably the distribution of WindowsMobile will decrease with the new Version WindowsMobile 7. Finally, there are some mobile phone operating systems not yet considered, e.g. Bada as the operating system for mobile devices, basically invented by Samsung.

Taking into consideration that WindowsMobile has some potential there are at least five different, widely incompatible, operating systems to consider while developing software for mobile devices.

So, other alternatives than the implementation of platform dependent applications for mobile devices have to be considered. Currently, the most promising approach seems to build applications based on HTML5 with JavaScript.

PLATFORM INDEPENDENT APPLICATIONS WITH HTML5

Currently, the only way for platform independent development of mobile applications seems to be HTML5 with JavaScipt. In the following subsections we will first provide an overview of new features provided by HTML5 that are important with respect to mobile learning scenarios. Furthermore, we discuss the challenge of how to integrate device specific hardware in these kind of applications. Last but not least, this section provides different alternatives that allow to easily develop HTML5 and JavaScript based mobile applications.

Important new features for mobile learning scenarios provided by HTML5

HTML5 provides a number of new features that almost all yield to the possibility to enrich HTML sites either by new communication mechanisms or by new presentation techniques. In the following the three most important new features with respect to mobile learning scenarios will be presented shortly:

Canvas: With the new CANVAS implementation HTML5 provides the possibility for an easy and flexible provision of 2D graphics. Therefore, the new CANVAS object provides e.g. the possibility to draw simple lines, circles and rectangles. Furthermore, images can be added to a canvas that can be moved, rotated and scaled. Furthermore, simple graphical functionality like transparency can be used. All these functions are available over simple JavaScript commands.

WebSockets: Historically, a website was only able for uni-directional communication from the website to the server. The only way to receive data from the server was implementing pull methods (ex, AJAX). This changed with the implementation of WebSockets, since this approach allows for bi-directional communication. In order to be able to receive data send over a WebSocket, the website needs to implement the different JavaScript-Callback methods:

- `onopen`: gets called when the WebSocket is openend.
- `onmessage`: gets called when a message arrives over the socket.
- `onclose`: gets called when the WebSocket connection is closed.

The `onmessage` method works just like a push call from the remote server.

Web Database: HTML5 provides an implementation of SQLite that allows associating a Web application with a local database and load remote data into it.

LocalStorage: consists in a hash table with 10Mb capacity to store values; these data are related to the Web application in online and offline mode.

FileSystem, Manifest and offline mode: The key of developing web applications is the combined use of FileSystem and the Manifest file. FileSystem is an API that provides an independent file system from other applications and user files. Manifest is a declaration of which are the files that make up the application by local references to them. The Manifest is used by browsers to download these files and load them to a local filesystem, allowing offline operation.

Geolocation: Given the capacity of current mobile devices, there are many applications that use the georeference api, HTML5 provides this api that allows to know the coordinates of the access device, so its possible integrate the information. The data available are: latitude, longitude, altitude, accuracy, altitude accuracy, heading, speed.

WebWorker: is a simplification to work with threads in a web environment, since the browser controls the threads; it is not possible to manipulate from Javascript. However, a WebWorker permits simultaneous and asynchronous operations, regardless of the strands of the browser.

Semantic elements: Allow roles different visual components of HTML, for example assign a header role to a div, and footer to another. Thus it is the device's browser that allocates positions screen as character of it.

WebGL: In addition to the new 2D capabilities provided by the HTML5 CANVAS, a third technology, closely related to HTML5 showed up recently that provides 3D capabilities based on OpenGL, called WebGL. Making use of this technology, it would be possible to easily enrich mobile learning scenarios by 3D content.

Alternatives approaches for developing platform independent applications with HTML5 and JavaScript

There are mainly two different approaches to deploy and run web-based application depending on the running environment. The first one is to use an HTML5-enabled web-browser to download and execute the application (download de web page and execute the JavaScript code). This approach hinders the program code to access the specific characteristics of the computer devices on which the browser is running but allows a broader portability. The second is to use a native application which includes an HTML5 engine, which is able to download and run the code of the page. In this case, the application normally provides an interface for the various devices the mobile computer has. Therefore, if the application needs to access the various hardware accessories the mobile device may have (like camera, GPS, temperature sensor) the second approach might be a better choice.

MOBILE SITUATED LEARNING

Mobile computing has been recognized as a fundamental support to implement activities based on the Situated Learning theory (Naismith et al., 2005). In order to make situated learning applications theory operational (Brown, Collins et al. 1989), identify the critical aspects of situated learning to enable it to translate into teaching methods that could be applied in the classroom. In response to this challenge, a practical framework for designing learning environments was produced (Herrington and Oliver 2000) and has the following components:

    C1. Provide authentic contexts reflecting the way the knowledge is used in real life.
    C2. Provide authentic activities.
    C3. Provide access to expert performances and the modelling of processes.
    C4. Provide multiple roles and perspectives.
    C5. Support collaborative construction of knowledge.
    C6. Promote reflection to enable abstractions to be formed.
    C7. Promote articulation to enable tacit knowledge to be made explicit.
    C8. Provide coaching and scaffolding by the teacher at critical times.
    C9. Provide for authentic assessment of learning within the tasks.

With this work we aim to show that HTML5 is a technology which allows the development of portable mobile applications based on the Situated Learning theory, especially those requiring georeferenced data, which is data associated to a geographical location. In the past, many learning applications with these characteristics have been developed: Spikol and Milrad (Spikol and Milrad 2008), develop a mobile game called Skattjakt which promotes children getting involved in different tasks such as exploration, content generation, collaboration, problem solving and navigation in space. Ogata et al. (Ogata, Yin et al. 2006), describes a computer supported ubiquitous learning environment (LOCH) for language learning. LOCH was conceived to assist overseas students to learn Japanese while involved in real life situations. Moop (Mattila and Fordell 2005) is a learning environment supported by mobile phones, through which the pupil analyzes his/her thoughts and makes observations. In SketchMap (Miura, Ravasio et al. 2010) the children carries a PDA and create a map using a stylus pen by drawing streets and placing icons such as hospitals or a municipal offices. Because of the stand of the technology which existed so far these applications had to be developed in native languages, thus making them not portable at all. We will now describe an application, also inspired by the Situated Learning theory,

which was completely developed in HTML5 and at the same time, has a rich functionality and is usable, as the tests results suggest.

EXAMPLE SCENARIO

In a wireless communication course at the Universidad Diego Portales in Santiago, Chile students learn about characterizing the propagation of electromagnetic signals. The methodology requires learning a set of theoretical propagation models using a commercial tool that simulates the area covered by the signal of transition antennas according to various models. This methodology has several limitations, being the most important that students learn how to simulate a model but there is no contact with the real world and it scales. Most of the models were created for predicting the coverage areas in specific landscapes, like small, medium or big cities; there are also models for free space or mountainous areas. Therefore, it is hard to teach what model works better without a test on the real world.

A new software was built with equivalent features to the one installed in the laboratory but using HTML5, so it can be used from anywhere at any time. Originally, the application was planned to be used exclusively on mobile devices but due to devices limitations of smartphones (limited HTML5 implementation level and absence of Google Earth's api), it was decided to develop two different interfaces, one for desktop computers' browser and another for mobile devices' browser. Both implement functionalities which complement each other allowing the student to "prepare" the learning scenario with the desktop computer and then make the practical experience on the field using a mobile device. Results from the experience on the field feedback in turn the model, which is stored in a server in order to allow the student to correct or fine-tune the model.

The experience starts in the classroom with the teacher explaining the theory of signal propagation. Then the desktop interface is used in a planning step in which the student sets the position and the parameters of real's transmission antennas for transmitting TV signals in a predefined geographical and chooses the models which are going to be tested. In a second step the student go out with a mobile device and simulates the models on the field looking how the signal theoretically propagates over the area he/she is physically located using the transmitter specifications previously loaded on the server, the simulation uses the antenna location and the device GPS coordinates to evaluate the models. The students have the possibility to also check on the field the population density of the areas the signal covers. The third and last step requires measurement equipment to compare the real signal with the simulated one. In this way, students can learn by themselves which model makes a better prediction on different locations. With these results, the student goes back to the desktop application and corrects the position of the antennas and the propagation model used, presenting finally their findings in the classroom. This methodology actually implements the information cycle which binds classroom learning activities with mobile on-the-filed learning activities, as described in (Baloian et al., 2010).

Desktop Browser Interface

The desktop browser Interface has 5 main features, each one can be reach from the tabs menu on the main, and these features are: Add a transmitter (antenna), Change the radiation pattern of the transmitter, Edit a transmitter, Evaluate the Spatial coverage and Evaluate the population coverage

Add Transmitter: The objective of this feature is provide a easy way to realise the planning step, this can be done by using a combination between web form, 2D map and a 3D map. The 2D map is used for locate a approximate location of the antenna, this map is synchronised with the 3D view. After the location is in the 3D view, the antenna can be set with a double click on it. After this the technical specifications of the transmitter can be filled in the form. The specification includes the propagation model. There is a single save button to record the antenna data into a *WebDatabase*.

Radiation Pattern: In order to compare different kind of antennas the software has a interface designed to specify any radiation pattern. Each physical antenna as a specific radiation pattern, this pattern defines the transmission power on an specific direction. This feature is implemented with a Jquery API and *Canvas*.

Edit a transmitter: The possibility to change and compare different models is provided by editing the antenna specification including models. The interface is similar to the "Add a transmitter" form in **Figure 17**.

Evaluate the Spatial coverage: The objective of the desktop browser application is compare different coverage areas associated to different propagation models, this is done by this feature and the procedure is very simple. The first step is selecting the antenna from a list and the second is click on the "evaluate" button. After doing this the application will evaluate on each direction the signal strength on a specific number of points between the antenna position and the coordinates at a radius distance on the current direction. For each point evaluation requires the terrain profile from the Google Earth API, this profile is the set of altitudes between the point and the antenna. On **Figure 18** there are a terrain profile view using *Canvas*, 3D view and 2D coverage associated to the current direction evaluation.

All the processing is on the client using JavaScript functions, so the user on his browser perceives this. After this process is done there is a large amount of generated data and graphics, so this feature can't be implemented on a mobile environment because of the devices restrictions.

Evaluate the population coverage: One of the most important learning objectives on the course is that the number of people covered by the signal is more important than the area. In order to accomplish this goal we include a feature from another application implemented by the Population density provided by Socioeconomic data and application center (SEDAC). This application provides a REST interface for consulting population density from an area expressed by a polygon of coordinates. On our desktop view there is a simple polygon generator using a 2D map. When the user creates it is automatically sent to the REST interface and the result is returns in an asynchronous way in a table form.

Mobile Browser Interface

The objective of the mobile interface is to allow the student to realize the second step described in before, this is done providing only the main feature distributed in two or three functionalities: login (optional), select an antenna, evaluate models. This interface was build using jQueryMobile which provides a similar aspect to an iPhone application and follows the first approach for developing mobile applications with HTML5 previously described.

Figure 17 - Add transmitter form in desktop browser
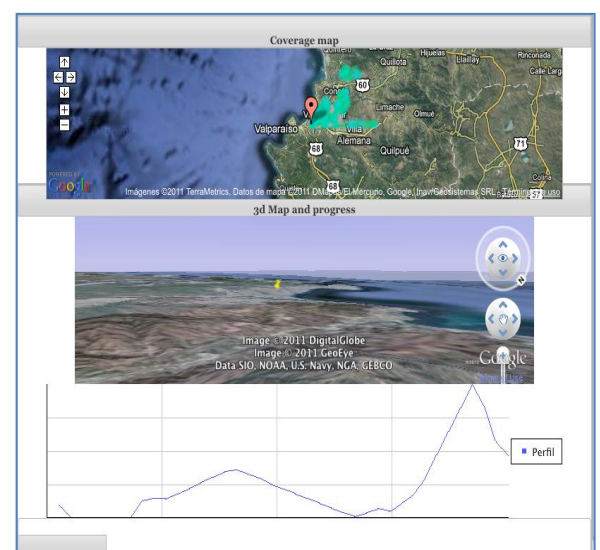
Figure 18 - Evaluation process on desktop browser

Select antenna: In order to allow the student to access the data created on the planning step this functionality provides the list of antennas. The student must select one and go back to the main view to proceed with the evaluation process.

Evaluate models: This functionality is which allow accomplishing the second step objective, the first thing the student has to do is locate the device pressing the Get Position button using **Geolocation** (see **Figure 19**a), after the device is located (see **Figure 19**b) the student can choose the models and compare them with the real measurements (see **Figure 19**c)

Report measurement: When a real measurement is made, this functionality provides an interface to register a georefered measure. This is done by pressing the Get Position button (see **Figure 19**d), entering the value and pressing the Report Value button.

a)   b)   c)   d)
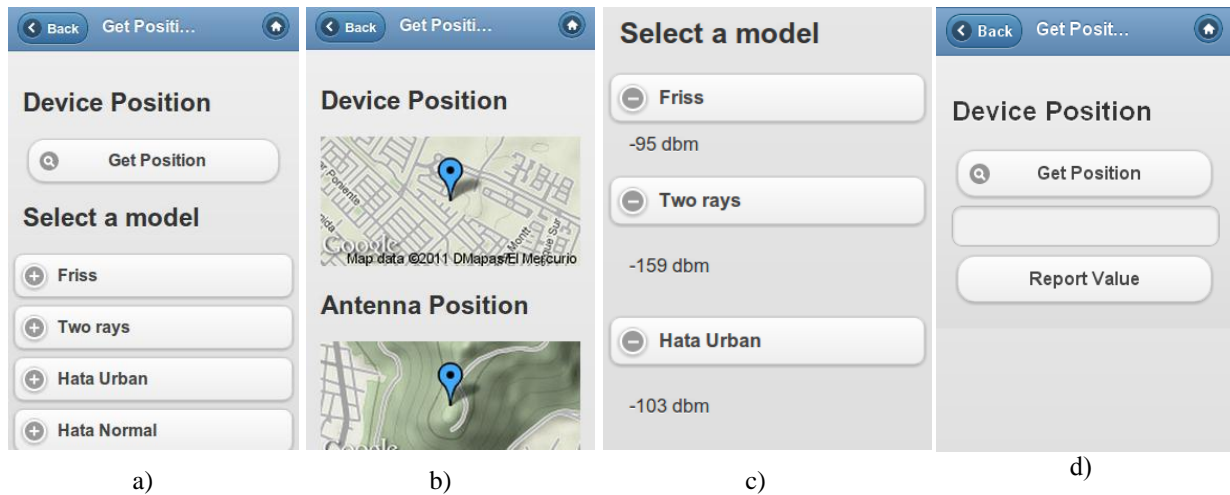
Figure 19 Mobile Browser Interface a) evaluating models functionality. b) locating device, c) evaluating models, d) report measurement.

TESTING THE APPLICATION

We wanted to evaluate mainly three aspects of the application. The first one is related to the performance and usability of the application developed in HTML5. The second one is about the response time of the HTML5-based application. Our concern here was that a HTML5-based application will be slower to react than an application written in native language, especially in those functions which involve a large amount of data transfer. This might have a negative impact on its usability. We also wanted to know the reaction of the students to the learning methodology which involves coordinated work between the desktop and the mobile computing environments, as well as the ability of this platform to support Situated Learning activities. So we can summarize the goals of this test by the following hypotheses which have to be confirmed or rejected:

- Hypothesis 1:   The HTML5-based graphical interface is usable and has an acceptable performance.
- Hypothesis 2:   The Web platform has good potential for developing collaborative applications.
- Hypothesis 3:   The students appreciate the value of HTML5 for implementing mobile learning applications.
- Hypothesis 4:   The methodology used is consistent with the main characteristics of Situated Learning.

For this, we designed five tasks (see Figure 4), each one aimed to test one or two specific characteristics of the application. A group of 22 students, 19 male 3 female, all between 20 and 23 years old in their 3rd year of the Computers and Telecommunication study participated in the experiment. This allowed us to include also technical aspects in the evaluation. They used they own mobile phones to carry on the experiment. They had mainly IPhone and Android models. The tasks were the following:

Task 1 – "Put one transmission tower where it covers the biggest area in Santiago city. The transmission power must be 8KW, 3 dbm in the transmitter and 0 at the receiver. The tower's height must be 100 meters and the frequency 456 MHz". This task was designed for testing the interface usability since it requires the use of various widgets. It also requires high graphics since it makes use of 2D and 3D maps. For this task HCI performance highly depends on the communication speed because of continuous downloading of geographic data from a central server.

Task 2 - "Indicate the areas in Santiago the signal does not reach". In order to have this answer from the system a considerable amount of calculations has to be done generating about 10 megabytes in graphics and data. Then the student must identify which areas of the City would have coverage problems. The purpose of this task is to stress the system to the limit of its performance capacity.

Task 3 – "Indicate under which propagation model there is signal perceived in the area x" This task aims to make the students perform an activity using real data, in a real environment. Specifically real measurement data of the outskirts of the city is delivered to the student and he is asked to choose which model of propagation is closest to the empirical data. It also stresses the application capabilities generating even more data after the previous task.

Task 4 – "Go to location X and measure the real signal strength with a TV signal meter, report the measured value using the mobile interface. Then indicate which model better explains this measurement, giving a

theoretical explanation" By performing this task the student will be expose to a mobile learning context performing authentic activities in the sense of Situated Learning.

Task 5 – "Indicate which model better explains the values reported by all students". This task allows collaborative knowledge construction by comparing the analysis of a single student's activity with the results obtained by the rest of the class.
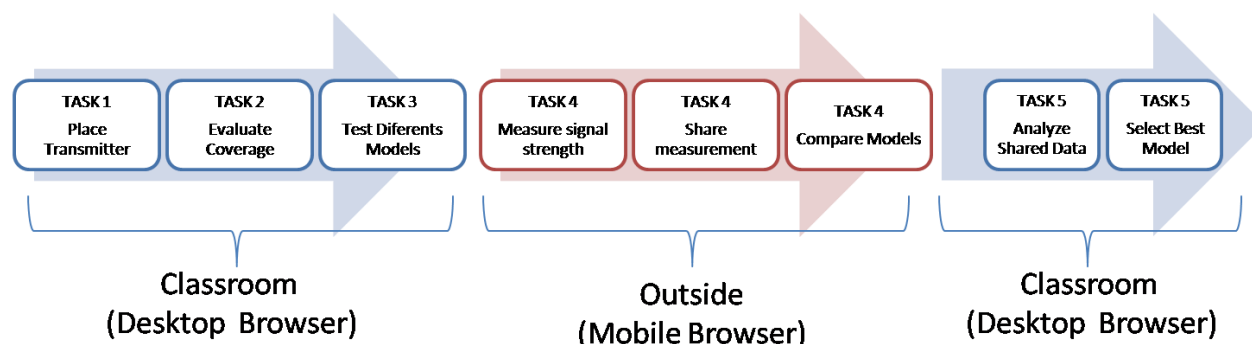
Figure 4 Tasks activities and contexts.

After performing the each task, the students answered a questionnaire consisting of ten statements. They had to declare their conformity with these statements with one of three options: disagree (-1), agree (1) and neutral (0). The questions should be answered comparing the HTML5 performance with a native application's performance (desktop or mobile). This considers the fact that students from the sample have strong background knowledge on software development and technologies. This allows them to effectively evaluate the advantages and drawbacks of a Web-based application against a native stand alone one.

The statements must be separated in two categories: Platform evaluations (Table 1) and Situated Learning evaluations (Table 2). The first three task were performed exclusively on desktop computers while the sentences refer to the combination of learning activities performed on both, mobile and desktop scenarios. On the column labeled with H we also show to which hypothesis each sentence is related to. Statements 1 and 2 where associated to Hypothesis 1, statements 3 and 4 to hypothesis 2, and statements 5 and 6 to hypothesis 3. Statements 7 to 10 are only applicable to a mobile learning scenario and are aimed to test hypothesis 4.

Sentence	H	T1	T 2	T 3	T 4	T5	Avg.
1.- The HTML5 application is easy to use	H1	0.64	0.91	0..82	0.45	0.85	0.70
2.- Response time of the HTM5-based application are longer	H1	0.09	0.27	0.09	-0.45	0.27	0.00
3.- Using the WEB was a limitation for performing the task	H2	-0.09	-0.55	0.09	-0.45	-0.82	-0.25
4.- The WEB easies the collaborative work	H2	0.64	0.55	0.36	0.55	0.73	0.52
5. - The HTM5-based platform has better potential than a native one.	H3	0.36	0.36	0.55	0.82	0.78	0.52
6. - I would like to perform more learning activities based on HTML5.	H3	0.33	0.45	0.45	0.64	0.60	0.47

Table 12 – Platform evaluation results, mean values and their relation to the hypotheses

Sentence	H	T 4	T5	Avg.
7. - I find it easier to assimilate the characteristics of the models using actual data.	H4	0,64	0.64	0.64
8. – I could understand that the learning activity performed in this experiment has strong similarities to the real activities professionals have to carry on.	H4	0.64	0.73	0.64
9. - The contexts differences were clear for different activities.	H4	0.73	0.73	0.73
10. - The use of an integrated tool was a contribution to the experience.	H4	1.00	1.00	1.00

Table 2 – Situated learning evaluation results, mean values and their relation to the hypotheses

DISCUSION AND CONCLUSIONS
Although the number of participants in the experiment was not too big we can state that statistically any positive result which is bigger than 0.5 has a meaningful value. Results between -0.25 and 0.25 can be regarded as neutral and significant. According to this and looking at the results on the table 3 we can derive the following conclusions:

- From the results of the first two first sentences from Table 2 we can conclude that the HTML5-based application is easy to use. This means, the widgets in an graphic interface created with this technology are understandable and easy to use. Despite our preliminary concerns about the performance of an HTML5-based this seems not to be a critical issue for the usability if the applications developed with this technology.

- According to results on sentences 3 and 4 in Table 2, the WEB as a platform for this kind of educational applications is accepted by the students. Sentence 3 was formulated in a negative way in order to avoid biases from the students during the answering of the questionnaire. So, the -0.25 is actually a positive number. However, the number does not represent a concluding opinion which means, students were neutral to the sentence. This hints to the conclusion that the WEB is not regarded as a hindering platform. On the contrary, numbers on sentence 4 give a significant positive result on this issue.

- As previously said, the technical background of the students used for the testings allowed them to effectively compare an application developed with HTML5 with a native one, since they can appreciate the benefits of a portable and always downloadable application and compare them against the drawbacks of a worse performance. Regarding the results, we see the students appreciate the advantages more than they dislike the drawbacks and they are willing to use other applications based on this technology, since both sentence related to this issue (5 and 6) have a mean value close to 0.5

- Finally, regarding the ability of this approach to implement learning scenarios Situated Learning we can say that although we did not test if all the components of Situated Learning were present in this activity, those we could test with sentences 8 to 10 report promising results: all sentences related to this have an evaluation over 0.5.

Overall we can conclude that the combination of HTML5 and JavaScript provide an interesting way for the development of platform independent mobile learning scenarios. Also the use of device specific hardware, usually necessary in mobile learning scenarios (e.g. to allow a contextualization), is possible by using external JavaScript libraries. There are also alternatives for the implementation of that kind of software, with respect to the complexity of the resulting product.

Although the obtained results are still not statistically concluding, nor the sentences cover all aspects we are interested to test, they do give us a strong hint that this approach has interesting perspective, since the advantages of mobility and portability seem to be more beneficial as the drawbacks of not using a native language for developing the applications. Furthermore, the presented approach is also transferable beyond mobile learning scenarios to corresponding areas like CSCW scenarios.

Regarding the ability of this methodology to implement the Situated Learning approach, In section 2. we cited the requirements for designing learning environments implementing Situated Learning. Here we will analyze how the presented system fulfils them.

C1: The data of antennas as well as signal strengths are taken from a real context
C2: Students have to measure real signals the way real professionals do
C3: Students are advised by an expert (lecturer) and use professional modeling and measuring tools
C4: Each task is performed assuming a different role in a different scenario
C5: Students have to share and compare their analysis results in order to find the best prediction model
C6: Students reflect on the results obtained in order to generalize the acquired knowledge
C7: The system allows students to collect data, relate and communicate them formalizing their unsorted ideas about what they find
C8: The teacher can help the students during the work on the field as well as back in the classroom
C9: Assessment is provided by the system automatically as a feedback for decisions taken about antenna location and model election

We are currently working on implementing more learning scenarios that follow the presented learning methodology (especially the learning information loop from the classroom, to the field and back to the classroom scenario) using the presented technology and we plan to have more massive testings to statistically validate this approach.

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Landmark-based Navigation System for Mobile Devices Have No Built-in GPS Receiver and Compass

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ABSTRACT

When users are roaming in real-life environment and looking for specific place for learning (e.g., Gothic architecture) or fun (e.g., Bar Tour for the happy hour), it is important for them to have a guidance from the map, the people, and may be the mobile phone! This research aims to design a navigation system on mobile devices for users doing mobile learning activities. Two issues are needed to be taken into consideration: (1) in the real learning environment such as national park or zoo, sometimes there is no road or no named road, and (2) not all mobile devices have built-in GPS receiver and compass and even the devices have GPS receivers, sometimes, it can not receive GPS signals due to the weather issue or the user is inside a building (e.g., museum). This research designs the navigation system based on the spatial relations of objects and landmarks. This system allows users doing learning activities in the real world with their mobile devices directly and no needs to purchase a new one or concern if it has built-in GPS receiver/compass.

Author Keywords

GPS, Location-Based Service, Mobile Phone, Landmark

INTRODUCTION

In the mobile learning environment, the users could receive the learning materials provided by the system wherever they are located (Wu et al., 2010). Users spend time for moving in the real world environment and time for learning the related knowledge of the learning spot. Users will have much more time in learning if they can find the learning spot immediately. Hence, a good navigation system can lead students to the right learning spot more quickly. Many positioning technologies can be used to develop location-based learning services on mobile devices, including GPS, two dimension code (e.g., QR Code), active/passive RFID and so on.

Priestnall and colleagues (2009) have evaluated five techniques for augmenting the visitor experience include pre-generated acetate, bespoke PDA application, multimedia on mobile phone, Google Earth on tablet PC, and head-mounted VR display. They have found that similar stability issues such as GPS connectivity in the five techniques do make applications perform badly. Lu and colleagues (2010) adopt QR Code to help users tell the mobile learning system where they are and to make users identify the learning objects required by the system inside buildings. However, it may not easy to establish such authentic environment fully with QR Code and RFIDs due to it maintenance and equipment cost. This research proposes a mechanism to guide users moving from one place to another in the real world with guidance messages just like the driving guidance systems in cars.

This paper is organized as follows. Section 2 introduces the research works related to spatial relations and landmarks. Section 3 describes the theory and the design of situated map in which the spatial relationships of objects can be stored. Section 4 focuses on the guidance message generation process and Section 5 talks how the proposed navigation system can be used in mobile learning. Section 6 describes the experiment plan, and at the end, Section 7 concludes this research and discusses the issues needed to be solved for next.

RELATED WORKS FOR DESIGNING LANDMARK-BASED NAVIGATION SYSTEM

Spatial Knowledge

Mohan and Kashyap have proposed an object-oriented model for representing the spatial knowledge in tree form (Mohan & Kashyap, 1988). All the objects in the real world can be represented in hierarchy form as Figure 1 shows. In Figure 1, the object o_2 is one component of o, and o_2 comprises o_{21} and o_{22} in the spatial knowledge structure. There are two benefits of using object-oriented representation to store the spatial knowledge: (1) it is easy to describe the relations among objects; and, (2) the structure could be changed to various forms depending on user's requirement.
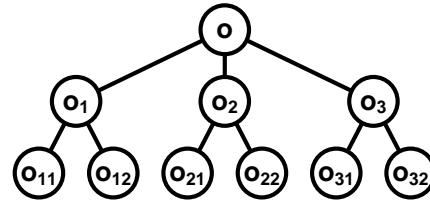
Figure 1. Spatial structure hierarchy (Mohan & Kashyap, 1988).

Del Bimbo has discussed about spatial relationships in geometry and he has classified the relationships into directional relationships and topological relationships (Del Bimbo, 1999).

- Directional relationships: A directional relation could be either in front of, back of, right, left, east, west, south, or north. All of these presentations are very general form of semantic. Directional relationships always stored in an array and the distance relationships between two objects are also stored in array.

- Topological relationships: Egenhofer and Fransoza have proposed a 9-intersection spatial model (Egenhofer & Franzosa, 1995). The 9-intersection model involves 29 topological relationships. Figure 2 shows an example about the operation of 9-intersection spatial model. There are three attributes for each object: Boundary, Interior, and Exterior. The matrix contains nine-intersections for object A and B. The left part of Figure 2 shows the situation of object A and B. For examples, because A's boundary touches B's boundary, hence, the value from A'b to B'b is 1; however, A's boundary doesn't intersect with B's interior, hence, the value from A'b to B'i is 0.
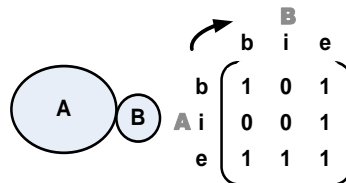
Figure 2. Topological relationships between object A and B (Egenhofer & Franzosa, 1995).

The 29 topological relationships can be categorized into eight categories, including "DISJOINT", "MEET", "INSIDE", "EQUAL", "CONTAINS", "COVERS", "COVERED BY", and "OVERLAP".

Landmarks

There are three basic elements to guide a human being moving in the real world: orientation, actions, and landmarks (Tversky & Lee, 1999). Orientation is the direction which helps people to know what direction he/she should go; actions give instructions to people and ask them to do some thing to reach the destination, such as turn left and straight forward; and, landmark is the essential thing to human to find way out, might more important than orientation (Golledge, 1999). Landmarks help people to organize space, and also give people as the reference in the world. Sorrows and Hirtle have proposed three landmark categories, visual, cognitive, and structure, each landmark category affects navigation method (Sorrows & Hirtle, 1999).

"Landmark Spider" is proposed by Caduff and Timpf (Caduff & Timpf, 2005), the landmark will be selected according to salience, distance, and orientation. Figure 3 illustrates the three characteristics between current position and the landmark. Salience is considering the obviously degree of landmark; distance is how far from current position to landmark; and orientation is the angle between current direction and the direction of landmark. This research uses a weighting function to select landmark, a, b and c are flexible according to users' needs: w_i = a*orientation + b*distance + c*salience.
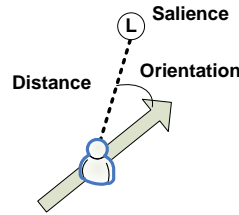
Figure 3. Salience, distance and orientation in landmark spider (Caduff & Timpf, 2005).

SPATIAL STRUCTURE IN THE REAL WORLD

The research goal is generating the guidance messages for users according to where they are at and the position of the learning spot in the real world. The guidance message is different from the traffic navigation message with GPS, because there are less obvious routes to users in the mobile learning environment such as zoo and museum than people driving or walking in the city. For instance, there is no named road like Jasper avenue or 13th street inside the park and the museum, so the system can not generate messages like "turn left on Jasper avenue" and "stop at the intersection of 13th street and 57 avenue".

Elements and Representation of Situated Map

In order to give the users moving instructions and lead them to somewhere they wants/needs to go, the spatial information should be known first. The spatial information is, for examples, the moving direction, related landmarks, and the distances. The most important is to know what landmarks that users can refer during their movement, such as a statue or a high building. This research designs a knowledge structure, *Situated Map*, to store the spatial information and the object relationships.

Situated Map (S-Map for short) is transferred from the real world maps with two elements: *Situated Axes* (denoted as AXE) and *Situated Objects* (denoted as o_i). Figure 4 shows a real map and the correspondent S-Map with two situated axes and many situated objects. The situated axes can be one dimension (timeline), two dimensions (real world 2D map), three dimensions (real world 3D map), and even more dimensions. All the situated objects on the S-Map are according to their (x, y) positions in this case, for example, the situated objects such as statue, sidewalks, and gardens, in the school campus.
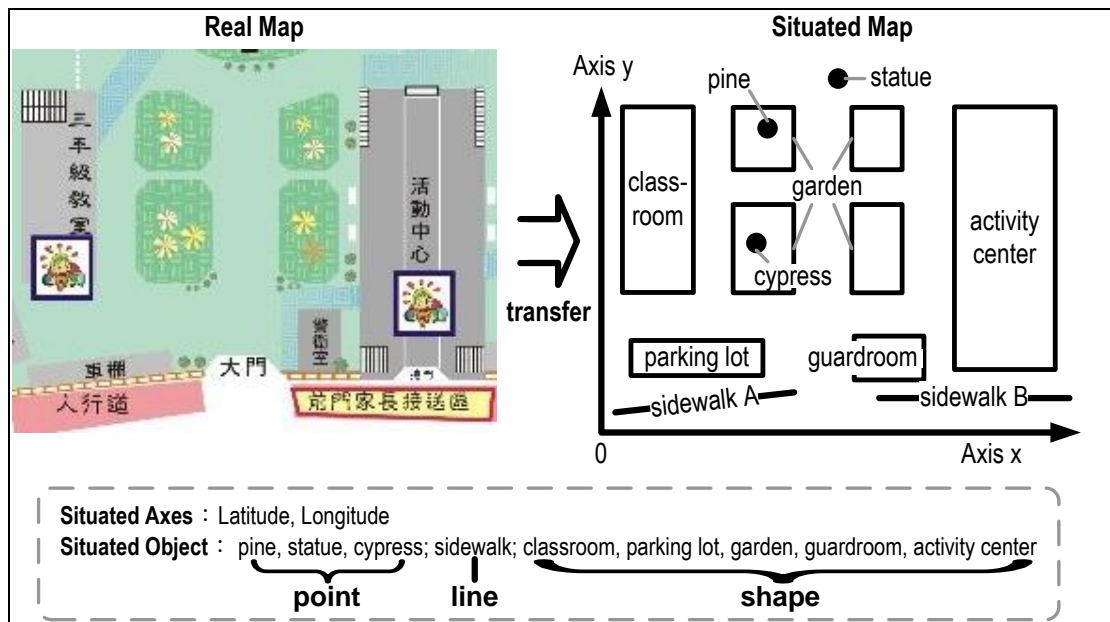
Figure 4. Real school campus map and the correspondent S-Map.

The objects on real map might be various, there are three major object types in S-Map: point (denoted as t_{point}), line (denoted as t_{line}), and shape (denoted as t_{shape}). The representation of the position is different to different object types in S-Map: the position of situated point object is (x_1, y_1); the position of situated line object is $\{(x_1, y_1); (x_2, y_2)\}$; and the position of situated shape object is $\{(x_1, y_1); (x_2, y_2); (x_3, y_3); (x_4, y_4)\}$.

Beside the situated object type and object position, situated objects have other attributes suchlike name and landmark flag. There is an additional attribute for the situated point object, i.e., learning object flag, this

attribute is used to indicate whether the point object is a learning object or not. Taking all attributes into consideration, a situated object is, o_{name} (type; position; landmark flag; learning object flag).

Spatial Relationships among Objects

The guidance message can not be generated with only the coordinates and the situated object types. Users might have no idea about the coordinates and directions in the real worlds, for instance, no one can tell the latitude and the longitude that s/he is at and few people can point (either real or magnetic) North direction out in cloudy day. Things that users might only know are the rough distance, relative direction (i.e., left-hand side of the entrance), and the names of the object that they can see. In order to generate appropriate guidance messages for navigation purpose, the spatial relationships include distances, relative directions, and topological relationships among situated objects have to know first. There are four relative directions: Front, Back, Right, and Left.

S-Map only consider five topological relationship categories in the 9-intersect spatial model: *DISJOINT*, *CONTAINS*, *INSIDE*, *COVERS*, and *COVERED BY*. Table 1 lists all possibilities of the directional relations and topological relationships that two situated objects may have.

Figure	Directional Relations	Topological Relationships	Figure	Directional Relations	Topological Relationships
	Front, Back, Right, Left	DISJOINT		Front, Back, Right, Left	DISJOINT, INSIDE, COVERED BY
	Front, Back, Right, Left	DISJOINT, INSIDE, COVERED BY		Front, Back, Right, Left	DISJOINT, CONTAINS, COVERS
	Front, Back, Right, Left	DISJOINT, INSIDE, COVERD BY		Front, Back, Right, Left	DISJOINT, CONTAINS, COVERS
	Front, Back, Right, Left	DISJOINT		Front, Back, Right, Left	DISJOINT, CONTAINS, COVERS
	Front, Back, Right, Left	DISJOINT			

Table 1. Directional and topological relationships that two situated objects may have

S-Map can transform the topological relationships among situated objects to a tree-like form as Figure 5 shows. The transforming method is based on topological relationships among objects, the contains/inside and covers/covered by topological relationships in particular. If the situated object A contains or covers B, then the situated object A will be the parent node of B. On the contrary, if A is inside or covered by B, then the situated object A will be the child node of B.
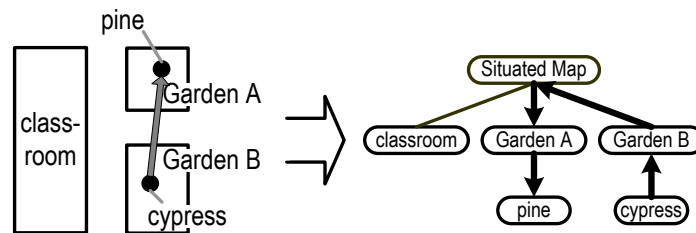
Figure 5. Tree-form S-Map.

Real World Movements and Situated Map Operations

Users move from one position to another in order to learn something or get close to the destination they want/need to go. The S-Map operations can be used as the movement indicators. On the left-hand side of Figure 5 represents a movement that users move from the cypress tree in garden B to the pine tree in garden A. Mapping such movement to the S-Map on the right-hand side of Figure 5, three S-Map operations, *Out*, *Move*, and *In*, are involved as Figure 6 shows. The Out-operation is from a child node to its parent node; the Move-operation is a transfer between two situated objects at the same level; and, the In-operation is a movement from a parent node to its child node.
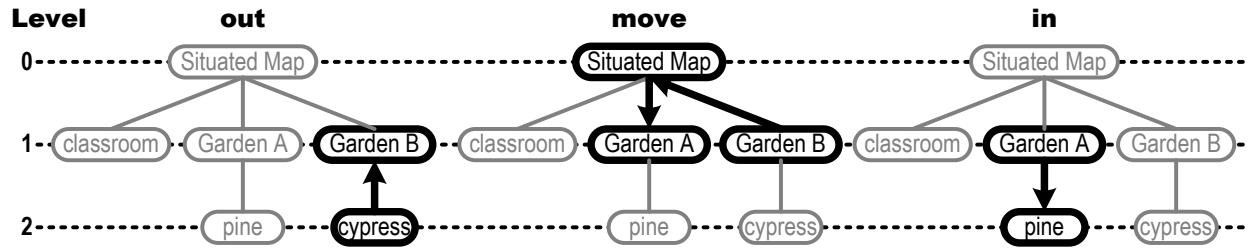
Figure 6. Three operations in S-Map.

NAVIGATION RULES AND GUIDANCE MESSAGE GENERATION

The guidance messages should consider the relative direction and distance between starting place and the destination as well as the objects that the users may encounter during the movement. The objects that users may see during their movement are so-called landmarks. Before giving a user movement instruction, it is important to know which direction the user faces, that is the orientation. It is important because that the user might see nothing if s/he heads to the wrong direction. So the navigation should also ensure that the user's orientation is correct. The navigation system can use the landmark to adjust the user's orientation, e.g., the first guidance message for the user is asking the user to make the landmark in front of his/her eyes.

Landmark Selection

The landmarks used in the guidance messages are also situated objects and can be picked-up from S-Map. The situated object might be a landmark candidate depends on the S-Map operations, taking situated objects in Figure 7 as examples: (1) in the Out-operation, movement from object D to object C, the situated objects which have the same parent object (e.g., object G) are landmark candidates; (2) in the Move-operation, movement from object C to object B, the situated objects which have the same parent object (e.g., object A and H) are landmark candidates; (3) and, in the In-operation, movement from object B to object E, the situated objects which have the same parent object (e.g., object F) are the landmark candidates.
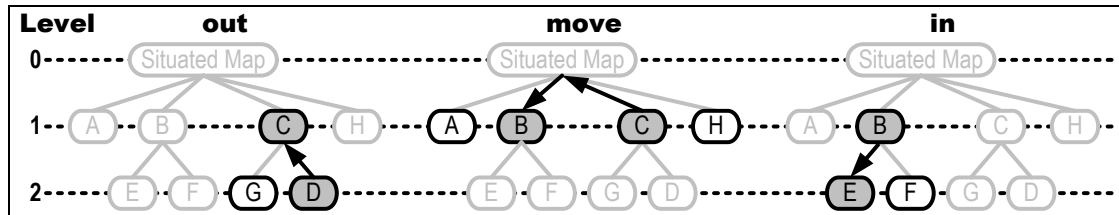
Figure 7. The landmark candidates (i.e., white boxes) in different S-Map operations.

Another issue needs to be solved before generating guidance messages is what landmarks can be used. A guidance message with landmarks makes users move in the real world easier, because users can know where they are and where they need to make a turn according to the landmark that they can recognize during their movements.

As abovementioned, the landmark is also a situated object and has its type, so the users will need to take different action when they encounter different landmark in real world. It makes a lot of sense, for instance, if the landmark is a pond, the users couldn't trespass it directly.

Point type landmarks

The situated point object is very common in the real world. In this research, the situated objects which are not related to the learning topic that the users are studying or are learning topic relevant objects but have been learned by the users are taking as landmark candidates. Figure 8 shows a route segment involves the starting place, the destination, and a point type situated object as landmark.
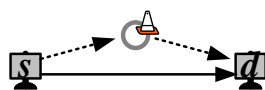
Figure 8. Point type landmark.
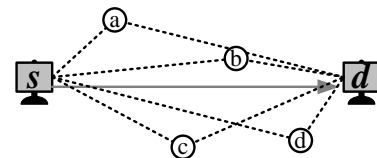
Figure 9. The point type landmark candidates.

Because the point type landmark is quite common in the real world, it is very important to make sure the chose landmark is the best choice. A good point type landmark should save users' time to travel and should be close to

the original way to the destination that users currently walking on. This research calculates the angle between two straight lines: the line from the starting place to the landmark and the line from the landmark to the destination. The larger angle the two straight lines have the total distance is shorter. Figure 9 shows four point type landmark candidates, a, b, c, and d. The angle of landmark candidate b is the largest, therefore landmark b is chosen as the landmark.

Line type landmarks

When choose a situated line object as landmark, the navigation system needs to consider if an intersection happened between the line object and the original way towards to the destination that the users are currently walking on. As Figure 10 shows, the navigation system will choose the landmark candidate at right-hand side as the landmark due to it can tell the users "keep walking until you reached the intersection of Jasper Avenue".
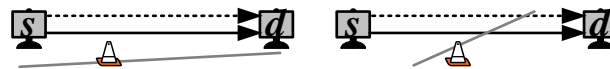
Figure 10. The line type landmarks.

Shape type landmarks

The situated shape objects can be the landmarks. Figure 11 shows that a shape object can be either trespass-able or no-trespassing when users move from the starting place to the destination. The shape object which is trespass-able suchlike park and plaza as the left-hand side of Figure 11 shows. On the contrary, users will need to make a detour to pass the no-trespassing situated shape object clockwise or anti-clockwise. However, users may have no idea of when they should stop walking around the no-trespassing situated shape object. In order to save users' time and make sure that users do keep moving on the same orientation, this research only chooses the trespass-able shape objects as the landmarks.
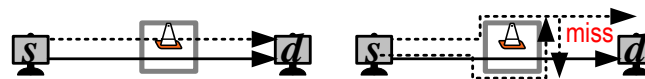
Figure 11. The shape type landmarks.

If there are many landmarks found in a single S-Map operation, the priority is shape type landmarks > line type landmarks > point type landmarks.

Guidance Message Generation

Users will receive the guidance message which includes the movement from (temporary) starting place to the landmark and the landmark to the (temporary/final) destination. Besides the (temporary) starting place, landmark, and the (temporary/final) destination, the guidance message also contains three instructions: *Direction Instruction*, informs users about what the relative direction they should face to, suchlike right, left, forward or back; *Distance Instruction*, tells users how far they should move, suchlike two meters; and, *Action Instruction*, instructs students what to do when they get arrived at the landmark or the (temporary/final) destination, such as arrive, find, pass over, cross, and meet the periphery.

The guidance message for users moving from (temporary) start point to the landmark therefore looks like:

> *your are at {(temporary) starting place} now, please turn {Direction Instruction} and walk about {Distance Instruction} until {Action Instruction} {the landmark}.*

The guidance message for users moving from the landmark to the (temporary/final) destination looks like:

> *please turn {Direction Instruction} and walk about {Distance Instruction}, you will find { the (temporary/final) destination}.*

PROPOSED NAVIGATION SYSTEM AND GUIDANCE MESSAGES IN MOBILE LEARNING

In general, the mobile learning flow is: at beginning, students study out of classroom and observe leaning objects; then they move to next learning spot when they completed the study there; and, repeat above steps until they finished all learning tasks. The proposed navigation system can then be integrated into the flow as Figure 12 shows.

At step 1, teacher builds the situated map according to the learning environment suchlike school campus; at step 2, the navigation system transform the situated map into tree-form situated map; at step 3, the system picks those situated objects can be learned by students from the situated map and offers these objects to them; at step 4, students choose the learning object they want and/or need to learn; finally, at step 5, the system generates the guidance messages to lead students studying in the real world.

Here is a simple example when Alex studies plants in the school campus. Figure 4 shows the school campus map. There are six situated objects in the campus: Garden A, Garden B, sprinkler in Garden A, pine tree in Garden A, cypress tree in Garden B, and another sprinkler in Garden B. Assuming Alex just finished the observation activity of the cypress tree in garden B and is going to learn the pine tree in garden A as Figure 5 shows. Figure 6 shows the three route segments and its S-Map operations. With the landmark analysis and guidance message templates, the navigation system then can generate the following guidance messages one by one:

1. The S-Map operation of the first route segment is "out", the landmark is sprinkler (point type) in garden B. The guidance message is

> Please turn {right-forward} and walk about {1.7 meters} until arrive {sprinkler}. Turn {right} and walk about {0.5 meter}, you will find {the edge of garden B}.

2. The S-Map operation of the second route segment is "move", there is no landmark in this route segment. The guidance message becomes

> Please turn {left} and walk about {1 meter} until arrive {the edge of garden A}.

3. The S-Map operation of the third route segment is "in", the landmark is sprinkler (point type) in garden A. The guidance message is

> Please turn {right} and walk about {0.5 meter} until arrive {sprinkler}. Turn {left-backward} walk about {1 meter}, you will find {pine}.
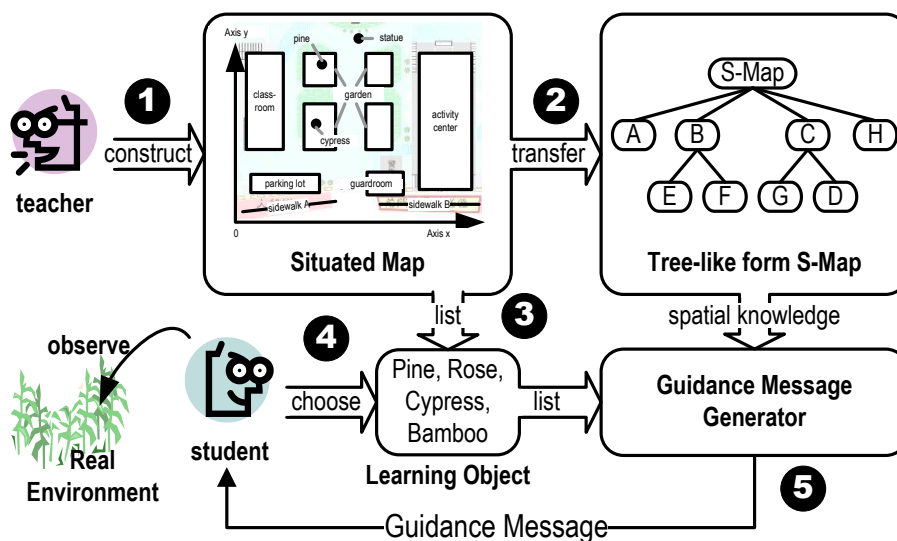
Figure 12. Proposed Navigation System in Mobile Learning

EXPERIMENT PLAN

The goal of this research focuses on how to generate guidance messages on the mobile devices have no built-in GPS receiver and compass as well as to guide users moving in the cloudy days and inside buildings. There is no experiment yet. However, an experiment plan is discussing and working on by researchers and teachers now, and the experiment is expected to do in this October. There will be 12 five-grade elementary school students (around 11 years old) in one class, and the experiment course will be biology and mainly focuses on the plants in the school campus. The course objective is teaching students plant shapes and organs, such as flowers, fruits, and seeds.

The experiment involves six steps:

1. Checking students' cognitive levels via pre-test and their past learning performances;

2. Choosing 3 different cognitive levels students and forming a small-group. There are two small-groups in both control group and experiment group;

3. Lecturing with traditional way in classroom;

4. Every small-group chooses their learning objects after school;

5. The small-group students in control group will do mobile learning without any guidance messages and the small-group students in experiment group will receive guidance messages during learning;

6. Finally, students need to have interview individually with teaching assistants.

Two goals of this experiment are: (1) does the guidance message human-readable? (2) does the guidance message could save student's time in travelling and searching learning object? The students in the same class are divided into two groups, the control group and the experiment group. The teaching assistant will accompany with the groups and record the time that each group spend on moving and searching specific learning object.

CONCLUSIONS

Mobile and wireless technologies make students learn the concepts and knowledge in the real world. However, with such ubiquitous learning model, students not only need to spend time to learn but also need to spend time to move and search the learning objects. The learning system should aware the context in the learning environment and lead students learning according to their locations. Although such location-based service can be well-implemented on GPS-enabled mobile devices such as iPad and Google Phone, two widely seen scenarios make things complicate. First of all, not all mobile devices have built-in GPS receiver and compass, e.g., eBook and most of regular mobile phones. Second, even a mobile device has built-in GPS receiver, the student might still encounter difficulty in using LBS services in many places and conditions, e.g., in the valleys, in the tunnel, inside museum, and at cloudy days. This research designs a landmark-based navigation system to lead students learning in the real world with those mobile devices have no built-in GPS-receiver and compass.

The navigation system currently only considers the relations among situated objects and doesn't take shortest path planning into consideration. Students might still need to spend long time to travel and search, because the system choose the path from one learning spot to anther based on if it is easy to navigate rather than distance. Beside *the shortest path issue*, this research simplified the problems by ignoring the curviform line objects and non-quadrilateral shape objects. How to transform these specific objects into the situated map is a big issue, which is *the object shaping issue*. Furthermore, this research also chooses to not take the no-trespassing situated shape objects as the landmarks. So how to inform users make a suitable detour to pass the no-trespassing situated shape object under the situation that the mobile devices have no location-aware feature is another issue, which is *the no-trespassing object issue*. At last, the geographical information should also be taken into consideration, because the landmarks might not be able to see by users due to its positions, heights, and even shapes, i.e., *the visibility issue*.

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TOPIC 5: Socio-cultural context of mobile learning

Long Papers

A Study of Factors That Influence Mobile Devices' Adoption in Language Learning Based on an Extended Model of TAM in China Higher Education

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ABSTRACT

This paper reports the findings of a study on factors that influence college students' acceptance of mobile devices for Mobile Assisted Language Learning (MALL) in China. An integrated model, namely Mobile Device Technology Acceptance Model (MDTAM) for foreign language learning in Chinese higher education, was proposed based on the Technology Acceptance Model (TAM). Two new factors, Perceived Ubiquity and Social Influences, were added to the proposed model. The model hypothesized five influencing factors, which formed nine hypotheses, i.e. nine paths from influencing factors to Behavioral Intention directly or indirectly. The MDTAM was verified using data collected from a questionnaire survey with 253 valid sample respondents in a southern university in China.

Structural equation model was adopted for data analysis including measurement model assessment and structural model assessment. Six hypothesized paths were proved. Three factors, namely Attitude, Perceived Usefulness and Perceived Ubiquity, significantly and directly influenced students' intention toward the acceptance of mobile devices in language learning, which accounted for 51.1% of the variance explained in students' Behavioral Intention. Additionally, the study results showed that among the two new factors, Perceived Ubiquity was of significant effect on Behavioral Intention. However, the other factor Social Influences has not been proved of significant impact either on Behavioral Intention or Perceived Usefulness. These findings may have reflected the unique English learning context in China. Hence, future research opportunities were proposed at the end of this paper.

Author Keywords

MALL, Technology adoption, TAM, MDTAM

INTRODUCTION

Due to the availability of mobile technologies such as mass communication, 3G networks, and related services, Smart phones, and handheld computing devices, M-learning (mobile learning) has evolved from concept to reality.

New mobile language learning practices are emerging via podcasting and just-in-time learning with flexibility in learning time and location (Shih, 2007). Current advancements in wireless technology support essentials for successful collaborative language learning (Shih, 2007).

The benefits of MALL indicate its great potential and promise in language learning, and English learning in China higher education is essential. To better ensure quality and effect of MALL, and to provide decision makers in educational institutions with some reliable policy guidance and implications regarding the application of MALL, it is necessary to explore factors influencing users' acceptance of MALL in foreign language learning.

LITERATURE REVIEW

Research on basic language learning activities in MALL from aboard is abundant. As vocabulary learning was a key issue for language learning, a large number of studies attempted to improve the efficiency of vocabulary learning (Thornton & Houser, 2003; Levy & Kennedy, 2005; Belanger, 2005; Norbrook & Scott, 2003). Some

other research studied on quizzes (Norbrook & Scott; 2003, Levy & Kennedy, 2005), listening (Belanger, 2005), speaking (Cooney & Keogh, 2007), reading (Lan et al., 2007) and writing (Samuels, 2003).

Second, in order to create effective applications of MALL and exploit the benefits of mobile learners situated in authentic, noisy conditions, some researchers (Ogata & Yano, 2003; Tseng, et al., 2006) studied how to construct MALL context. Other researchers, in order to reflect the characteristics of language learning, were interested in adapting mobile learning systems to language learning (Fallahkhair et al., 2005; Chen et al., 2008).

Third, some researchers (Kukulska-Hulme & Shield, 2008; Petersen & Divitini, 2005) focused on defining ways in which mobile devices can support language-learning communities of practice (Lave & Wenger, 1991) when their members were separated by distance.

Although MALL has certain applications, we still do not know the factors influencing users' intention of mobile devices adoption in foreign language learning. Few studies investigated the factors influencing the acceptance of MALL from learners' perspective. Hence, few appropriate suggestions are available for present MALL application. In summary, just like Kukulska-Hulme & Shield (2008: 283) say, "MALL seems to be in its infancy; until relatively recently, MALL activities rather mirrored early CALL activities where electronic quizzes, grammar drills and vocabulary lists dominated".

Domestic research on MALL can be classified into two groups. One group is those from ICT (Information & Communication Technology) in education field. For example, a few master degree theses of ICT in education field referred to MALL research (Luo, 2006; Wang, 2007; Tao, 2008). This group, mainly from technical perspective studied on the design of MALL system. Most of these studies did not refer to users' feedback except one research from Tao (2008), who presented users' opinions on MALL. Although these systems provide vocabulary, reading and visual content as well as discussion areas, the effect of application needs evaluating.

The other group is those from commercial organizations or the alliance of commercial organizations and publishing institutions, which include wireless telecommunication supplier (for example, China Telecom) and mobile termination makers (for example, Mobiledu series phones made by Nokia). Both of them cooperated with educational training organizations or publishing and broadcasting media to provide language learning materials, for example, Nokia developed special websites to provide mobile learning courses of Foreign Language Teaching and Research Press, New Oriental, BBC, VOA, etc. (Tian, 2009). The activities of this group were mainly commercial practices, which was in the dominated position of MALL research at home. This kind of mobile language learning courses, which was mainly regarded as a marketing way to extend main business by wireless telecommunication suppliers and mobile termination makers, was often provided to users free. However, the effects of these applications were not reported (Tian, 2009).

Though mobile learning provides promise for language learning, why learners accept or reject mobile devices in language learning is far from being completely understood. Previous MALL research both at home and abroad designed language-learning materials from designers' perspective, not from learners' perspective to investigate factors influencing their adoption of mobile devices in foreign language learning. Researchers (Shih, 2007) evaluated the effect of MALL comparing with CALL and studied the acceptance of mobile technologies and 3G services based on TAM (Kim & Garrison, 2009; Wu et al., 2007; Gong, 2006; Lu et al., 2009), but few academic researches explored the factors influencing users' intention to accept mobile devices in foreign language learning by using TAM as the theoretical framework, especially among college students.

In fact, learners are the final determinant of mobile devices adoption in foreign language learning. If learners do not accept them, they cannot perform their learning initiative in MALL, and the application of MALL is out of the question. All efforts will be in vain. Therefore, there is a need for more substantive understanding of factors influencing college students' acceptance of mobile devices in foreign language learning in the context of English learning in China.

RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

Technology Acceptance Model (TAM)
TAM, introduced by Davis (1989) is one of widely used and accepted models to explain information technology (IT) and information systems (IS) acceptance (Kim & Garrison, 2009). It has been widely used to predict user acceptance based on Perceived Usefulness (PU) and Perceived Ease of Use (PEU) (Davis, 1989). TAM, rooted in the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), asserted that beliefs influence attitudes, which lead to intentions and result in some type of behaviour (Kim & Garrison, 2009). Figure 1 illustrates the original TAM model.
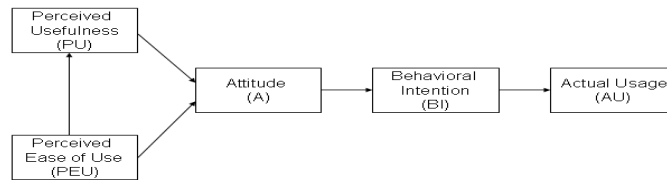
Fig.1 Technology acceptance model (Davis 1989; Davis et al. 1989)

Building on TRA, TAM posits that actual system use is directly determined by Behavioural Intention (BI) to use. BI is in turn influenced by user's Attitude (A) toward using an information system/technology. Users' Attitude toward an information system/information technology was then determined by two particular beliefs: PU and PEU. PU refers to "the extent to which a person believes that using a particular technology will enhance her/his job performance," and PEU as "the degree to which a person believes that using a technology will be free from effort" (Davis et al., 1989: 985).

TAM was applied to many different sample sizes and user groups within or across organizations, and compared with competing models (Gefen, 2000; Agarwal et al., 2000). A significant body of literature has included TAM as the theoretical model either as a whole or extended to additional constructs (Kim & Garrison, 2009). Some (Lu et al., 2003; Kim & Garrison, 2009; Wu et al., 2007) even adopted it for the investigation of mobile technology adoption.

Although studies on the acceptance of mobile technology have attracted much attention from researchers, few studies explore the factors influencing users' acceptance of MALL, even fewer literature is available on it among college students in China. Following earlier TAM research, it is expected that the general causalities found in TAM are also applicable to mobile devices adoption in foreign language learning context. Therefore, we hypothesize:

Hypothesis 1: PEU will have a positive effect on PU;
Hypothesis 2: PEU will have a positive effect on A to use mobile devices in foreign language learning;
Hypothesis 3: PU will have a positive effect on A to use mobile devices in foreign language learning;
Hypothesis 4: PU will have a positive effect on BI to use mobile devices in foreign language learning;
Hypothesis 5: A toward using mobile devices will have a positive effect on BI to use mobile devices in foreign language learning.

Perceived Ubiquity and Social Influences as Extensions of TAM
Based on the findings of previous studies, we extended TAM model by adding two more constructs, namely, Perceived Ubiquity (PQ) and Social Influences (SI).

The original TAM did not include Subjective Norm (SN) or SI. Nevertheless, social psychologists (Robertson, 1989) knew that the social context of an individual can change his or her perception of unchanging physical objects. SN was defined as "a person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein & Ajzen, 1975: 302). The more an individual perceives that significant others think he or she should engage in the behaviour, the greater an individual's level of motivation to comply with those others (Ajzen & Fishbein, 1980). SI was equivalent to SN and defined as other people's opinion, superior influence, and peer influence (Taylor & Todd, 1995a). Previous studies showed that SI can play a determinant influence on users' behaviours (e.g., Hoffman et al., 1996).

Therefore, we put the construct SI into our research and propose that it may influence college students' intention of mobile devices adoption in language learning. We hypothesize:

Hypothesis 6: SI will have a positive effect on PU;

Hypothesis 7: SI will have a positive effect on BI to use mobile devices in foreign language learning.

PQ is a relatively new concept in IS/IT literature, but is becoming more popular in research dealing with wireless technology. It refers to "an individual's perception regarding the extent to which MWT (Mobile Wireless Technology) provides personalized and uninterrupted connection and communications between the individual and other individuals and/or networks" (Kim & Garrison, 2009: 326). Some researchers (e.g., Looney et al., 2004) claimed that the capability of communicating from virtually anywhere at any time offered extraordinary levels of flexibility and convenience, which may affect BI and be one of the factors influencing the diffusion of MWT.

Similarly, we argue mobile devices' ubiquity provides users with freedom in time and location, which may influence their BI. Moreover, the easier a technology or device is, the more ubiquitous it is. So we contend that, in China higher education context, users' perceptions about the easiness of a mobile device in her or his language learning will positively influence the perceptions of ubiquity. Therefore, we hypothesize:

Hypothesis 8: PQ will have a positive effect on BI to use mobile devices in foreign language learning;

Hypothesis 9: PEU will have a positive effect on PQ.

Figure 2 presents the proposed research model referred to as MDTAM. As the name implies, MDTAM is theoretically grounded in TAM in that it retains the constructs PU, PEU, A and BI, but extends TAM by incorporating two additional theoretical constructs - PQ and SI. As shown, the dependent variable–intention of mobile devices adoption–is posed as the primary construct to determine learners' acceptance of mobile devices.

RESEARCH DESIGN

This quantitative study focuses on investigating factors that may affect college students' acceptance of mobile devices in foreign language learning by verifying a proposed model. Questionnaire survey is employed to solve the research purpose. This data collection method results in numerical data that is then analysed primarily by statistical methods.

Questionnaire is used to measure the constructs in TAM. All of the items in questionnaire were developed from previous studies about technology acceptance, such as Davis (1989), Taylor & Todd (1995a, b), Kim & Garrison (2009). They were measured using a five-point Likert scale ranging from "strongly disagree" to "strongly agree". All items were randomly arranged and some of them were negatively stated to reduce a potential "say-yes" response (Gong, 2006).

A pilot study using 25 students was conducted to test the reliability and readability of primary questionnaire. According to the results of pilot test, we adjusted the questionnaire.

Based on convenient sampling process, 400 students were recruited from a university in South China, either or not using mobile devices in foreign language learning. Self-administrated questionnaires were delivered in the study.
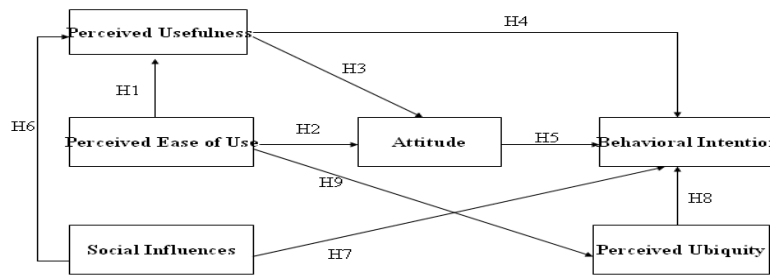
Fig. 2 Mobile devices technology acceptance model

TEST FOR VALIDITY AND RELIABILITY

The construct validity was assessed by item loadings using principal component factor analysis. The KMO value was .872 and the Bartlett's Test of the questionnaire was significant, which showed the principal component factor analysis is acceptable (Ramayah et al, 2006). However, the results of factor analysis showed low validity.

To improve the validity, nine items were discarded from the questionnaire because of their large residuals. A second run of factor analysis was conducted. We used the criteria used by Igbaria et al. (1995) to identify and interpret factors, which was that each item should load 0.50 or greater on one factor and 0.35 or lower on the other factor. The results showed improved validity (Appendix A) that could be accepted for further analysis. Hence, Model 2 (see Figure 3) formed by these items was analysed in the following testing.

Item reliability was examined by Cronbach's coefficient alpha analysis. Cronbach's alpha estimated for constructs in this study ranged between .715 (SI) and .869 (A) (see Appendix A). This meant that reliability of the instrument was within acceptance level suggested as >.70 by Hair et al. (1998).
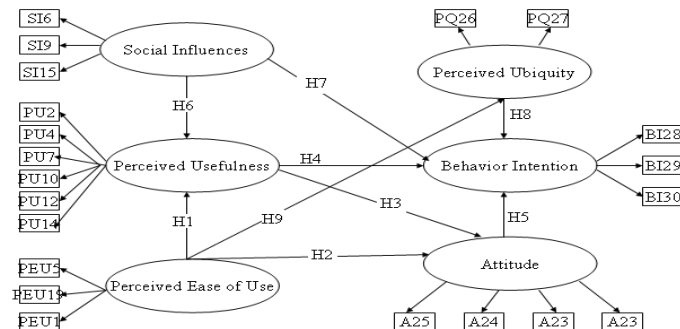
Fig.3 Mobile devices technology acceptance model 2

MODEL TESTING

The model testing includes two stages: measurement model assessment and structural model assessment. AMOS 6.0 was the main statistic tool used in the analysis.

Analysis of Measurement Model

The first step to analyse the measurement model was to check the purification through assessing the goodness-of-fit test of was assessed by Chi-square/degrees of freedom (χ^2/df), Goodness-of-fit Index (GFI), Adjusted Goodness-of-fit Index (AGFI), Normed fit index (NFI), Comparative Fit Index (CFI), and Root Mean Square of Approximation (RMSEA). Thresholds for good fit was deemed to exist when the value of GFI, NFI and CFI was greater than 0.90 (Bentler, 1990), RMSEA was around 0.1, and AGFI was greater than 0.80 (Henry & Stone, 1994). χ^2/df was less than 3 which was considered adequate (Carmines & McIiver, 1981).

The overall fit indices (see Table 1) suggested that Model 2 well fit the data. All the indices met the recommend value for goodness-of-fit.

Model	NFI	GFI	AGFI	CFI	χ^2/df	RMSEA	$P(\chi^2)$	RMR
Measurement model 2	0.922	0.943	0.917	0.994	1.080	0.018	0.233	0.046
Recommend value	>0.9	>0.9	>0.9	>0.9	1< <3	<0.08	>0.05	<0.05

Table 1 Summary of overall fit indices for the measurement Model 2

Analysis of Structural Model and Hypothesis Tests

Following measurement model assessment, the structural model was evaluated to test the relationships between the constructs proposed in MDTAM. Table 2 and Fig.4 show the results of hypothesis-testing and path coefficients with their respective significance levels.

As we expected, most of TAM variables in MDTAM were consistent with previous studies. H1 predicted that PEU had a positive impact on PU. The result indicated the expected effect ($\beta = 0.567$, $p < 0.001$). The positive path coefficient (0.567) between the two constructs provided evidence to support H1. The positive path coefficient ($\beta = 0.720$, $p < 0.001$) between the PU and A supported hypothesis--H3. Additionally, both PU ($\beta = 0.304$, $p < 0.001$) and A ($\beta = 0.359$, $p < 0.001$) were also significant predicators of the intention of mobile devices adoption, thereby supporting H4 and H5. PU was explained by a variance of 32%, and A with 48%.

Consistent with our hypotheses, the results indicated the new adding factor-PQ had direct effect on BI. The positive path coefficient between them ($\beta = 0.176$, $p < 0.05$) provided evidence to support H8. The positive path coefficient between PEU and PQ ($\beta = 0.520$, $p < 0.001$) supported H9. PQ was explained by a variance of 27%. All the constructs in this model explained 51% variance in mobile devices acceptance, i.e., in an individual's BI toward using mobile devices in language learning.

However, inconsistent with our hypotheses, the results showed that SI had no positive effect on PU and BI, and PEU had no positive impact on A toward using mobile devices. Therefore, H6, H7 and H2 were not supported in this model.

Hypothesis	Effects	Path coefficients	p-value	
H1	PEU→PU	0.567	p<0.001	Support
H2	PEU→A	-0.049		Not support
H3	PU→A	0.720	p<0.001	Support
H4	PU→BI	0.304	p<0.001	Support
H5	A→BI	0.359	p<0.001	Support
H6	SI→PU	-0.017		Not support
H7	SI→BI	0.100		Not support
H8	PQ→BI	0.176	p<0.05	Support
H9	PEU→PQ	0.520	p<0.001	Support

Table 2 The results of the tested hypotheses
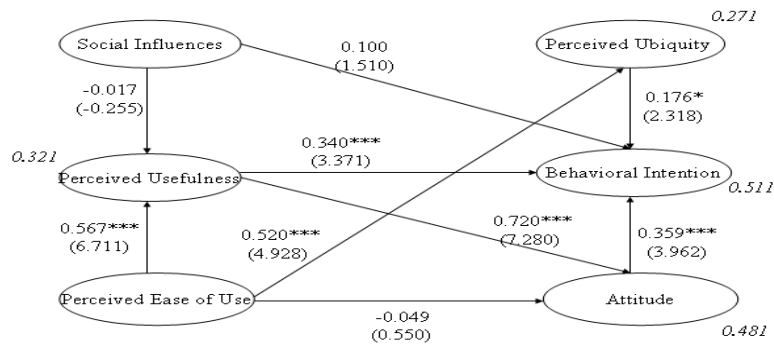
Fig. 4 The results of the structure equation model (SEM)

*Regular numbers represent "Standardized Regress Weight" (Factor Loadings), whereas italicized numbers represent "Squared Multiple Correlations" (R^2). Numbers with ( ) represent t-value. *p<0.05; **p<0.01; ***p<0.001*

DISSCUSSION

This study aims to shed light on the factors influencing college students' intention of mobile devices adoption in foreign language learning by examining a proposed MDTAM. The overall explanation power of the research model is high with a R-square of 51.1% in total of the variance on intention of mobile devices adoption. Comparing with previous studies, the explanatory power of this research model for BI is higher than Chau and Hu (2001) with $R^2=0.42$, Schepers and Wetzels (2007) with $R^2=0.48$, Turel and Yuan (2007) with $R^2=0.457$ and Shin (2007) with $R^2=0.316$. This suggests MDTAM is capable of explaining a relatively high proportion of the variation in the intention of adopting mobile devices.

Among the nine hypothesized relationships, six of them are supported in this study. Consistent with previous TAM literature (Davis et al., 1989; Venkatesh & Davis, 2000; Kim & Garrison, 2009; Wu et al., 2007), the results indicate that PEU positively and significantly influenced PU; PU has a positive and significant effect on A; both A and PU have a positive and significant effect on BI.

However, PEU has no positive impact on A (H2). This is inconsistent with the findings of previous research (Ajzen & Fishbein, 1980; Davis et al., 1989). Though the result is surprising to us, a previous study also found that PU mediated the effect of PEU on other factors (Davis, 1989). Moreover, mobile device, as a convenient communication tool, has successfully attracted the younger generation. Our sample was all students; it was easy for them to use mobile devices as they were regarded as the pioneer users of new technological products (Zhang & Hu, 2008). Therefore, the easiness of mobile devices may not influence students' attitudes toward the usage. That is why PEU has no direct effect on A.

Interestingly, four new findings are generated from the study. First, Fig. 4 shows the intention of using mobile devices in language learning is directly and significantly affected by three factors, namely PU ($\beta=0.34$), PQ ($\beta=0.176$) and A ($\beta=0.359$). Among these relationships, A and PU are two important predictors of influencing users' BI to use mobile devices in language learning. This supports TAM, which predicted that A and PU were significant determinants of BI. A has long been shown to influence BI (Ajzen & Fishbein, 1980). This relationship has received substantial empirical support (Wu et al., 2010; Taylor & Todd, 1995a, b; Chen et al., 2007; Shin, 2007; Lu et al., 2009).

However, the result shows that A has the highest contribution to college students' intention of mobile devices adoption in foreign language learning. This is different from Davis (1989) and Davis et al. (1989), which showed that PU was a major determinant of BI. But this finding also verifies the results of Shin (2007) and Lee et al. (2005). This indicates that students' attitudes toward mobile devices strongly determine their willingness to use them in foreign language learning.

Second, the results demonstrate the new factor, PQ, influences college students' intention of mobile devices adoption in foreign language learning. This is consistent with our hypothesis and proves the conclusion of Kim and Garrison (2009).

Third, the results prove that PEU positively and significantly influences PQ, which conforms to our prediction. It may reflect real life, because the easier one felt to use a technology or mobile device, the more ubiquitous that technology or mobile device would be. If college students felt it was easy to use a Smartphone or a mobile device, they felt that technology or mobile device was in reach, or at least not far away. This may have positively affected their intention to use it in foreign language learning.

But the other new factor - SI is not supported in this model. The results indicate SI has no significant influence on PU (H6), which is inconsistent with the findings of previous research (Venkatesh & Davis, 2000; Ajzen & Fishbein, 1980；Lu et al., 2003 Karahana et al., 1999). The results also show that SI has no positive and significant influence on BI, which is inconsistent with the findings of previous research (Taylor & Todd, 1995a; Venkatesh & Davis, 2000; Hoffman et al., 1996; Karahana et al., 1999).

TRA postulated that SN was a key determinant of BI based on the rationale that people tend to perform behaviour that important referents think they should (Kim, 2005). However, researchers found a nonsignificant effect of between them (Davis et al., 1989; Chau & Hu, 2001). They attributed the result to highly autonomous nature of the profession. On the other hand, Venkatesh and Davis (2000) suggested that SI exerted an influence on intention when use of a system was mandatory, but not when it was voluntary. From this perspective, using mobile devices to learn foreign languages in Chinese colleges was a voluntary-usage, which was different from other countries. Accordingly, it is reasonable to understand that the effect of SI on intention of mobile devices adoption is nonsignificant.

Additionally, some other reasons may lead to this result. First, the application of MALL in China is still at the initial stage, college students lack enough references from prior adopters such as friends and superiors.

Second, the result may be affected by the measurement scales of SI in questionnaire. SI in this study was defined as "other people's opinion, superior influence, and peer influence" (Taylor & Todd, 1995a). We referred to the measurement model with the items, "teachers influenced my behaviour to use mobile devices in language learning," "classmates influenced my behaviour to use mobile devices in language learning," and "advertisement and media influenced my behaviour to use mobile devices in language learning." The means of the three items were 2.76, 2.55, and 2.68 respectively. This reflected that a large number of respondents did not agree with these opinions. In other words, their acceptance of mobile devices in language learning may not be influenced by teachers, classmates, advertisement, and media at all, but by some other persons or factors. This needs to be investigated and explored in future research.

Third, this result may reflect that Chinese college students born in the nineties are more independent and have their own views and opinions on something in question, which may be their own special characteristics of that generation. So they may not be influenced by surrounding person and environment at all.

CONCLUSION

This study utilizes TAM as the theoretical basis to investigate factors influencing Chinese college students' intention of mobile devices adoption in foreign language learning. Several insightful results could be summarized from our research as follows.

First, A is the most important predictor of the mobile devices adoption in foreign language learning. Thus, it is suggested that college students' attitudes could strongly determine their willingness to use mobile devices. Language educators can offer managerial support to promote positive beliefs and advantages of mobile devices in foreign language learning.

Second, PU is the second most important determinant of students' intention to accept mobile devices in language learning. Results reveal students' perceptions of usefulness and effectiveness of mobile devices may directly influence their intention to adopt mobile devices, and indirectly influence them via their attitudes.

Third, the new added factor PQ is also an important factor in the acceptance of mobile devices in language learning. Providing the uninterrupting connecting and communication with others at anytime and at any places is essential for college students in foreign language learning.

However, PEU does not have a significant effect on A toward using mobile devices in foreign language learning. The result may suggest that the easiness of mobile devices is not a key factor influencing college students' attitudes toward using mobile devices in foreign language learning. It is necessary to re-examine the relationship between them in other contexts or groups in future research.

Lastly, SI does not have a significant effect on either PU or BI. This nonsignificant effect may be attributed to the voluntary usage nature of mobile devices, or the characteristics of Chinese college students. This results call for the re-examination on the effectiveness of SI in the context of MALL.

There are some limitations to our study. It is only conducted in a university. Differences may exist in different regions and countries. Second, the explained variance of A and BI are about 48% and 51% respectively. This demonstrates that factors beyond in the model had effects on these two variables. Future studies are necessary to explore those factors that would affect mobile devices adoption in language learning and integrate them into the model.

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Appendix A:

Reliability and validity test of the items

Construct	Items	Loading	Cronbach's alpha	Mean	Standard Deviation
Perceived Usefulness	PU2	.636	.816	3.71	0.89
	PU4	.753		3.28	0.95
	PU7	.595	.	3.56	0.96
	PU10	.591		3.58	0.85
	PU12	.712		3.63	0.91
	PU14	.550		3.84	0.87
Perceived Ease of Use	PEU1	.742	793	4.06	0.92
	PEU5	.825		3.63	0.99
	PEU19	.780		3.82	0.94
Perceived Ubiquity	PQ26	.796	.734	3.97	0.94
	PQ27	.684		3.50	0.95
Attitude	A22	.716	.869	4.27	0.89
	A23	.784		4.17	0.87
	A24	.823		4.13	0.89
	A25	.809		4.15	0.87
Social Influence	SI6	.780	.715	2.55	1.09
	SI9	.585		2.76	1.13
	SI15	.721		2.68	1.04
Behavioral Intention	BI28	.688	.789	4.04	0.9
	BI29	.716		3.80	0.98
	BI30	.670		3.56	1.02

Learner voice in the context of mobile learning for disaffected young people

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ABSTRACT

Schools and educational institutions are facing increasing disengagement by young people as the numbers of excluded or marginalised young people continues to rise despite government intervention. The concept of learner voice has been adopted across a number of educational institutions and where it is embedded, evidence suggests it can be transformative in terms of culture, staff and learners. Learner voice has not been much in evidence in the context of transforming pedagogical practice in schools where use of ICT by young people is concerned. Whilst young people are avid consumers of technology, social networks and games, their use is not often considered to be learning, hence internet enabled mobile devices such as phones and games consoles are often banned and access to sites popular with young people are commonly blocked.

One possible solution to the problem of disengagement is to develop the concept of learner voice with regard to mobile technologies, accessing social networks and communities of practice through a range internet ready devices with a view to re-integration into more traditional learning or employment. This research focused on a group of marginalised young people who had not worked or taken part in learning for an extended period. They influenced the design and development of a prototype learning platform and piloted it over a 13 week period.

The young people engaged with the platform throughout the pilot, evidenced by the number of interactions generated for the duration. It would appear that learner voice used in conjunction with mobile technologies and software such as bespoke social networking sites developed specifically for learners and by learners could potentially serve to support the re-engagement of marginalised young people.

Author Keywords

Learner voice, mobile technologies, social networking, Web 2.0, marginalised, disaffected.

INTRODUCTION

The notion of learner voice and its potential to aid the process of learning is a concept adopted by a number of educational institutions. In its simplest form, young people are represented on committees or involved in staff recruitment. Where learner voice is more embedded, it has been recognised as potentially transformative for the institution, influencing pedagogical practice and organisational decision making, whilst encouraging deep learning in the student.

It is widely recognised that young people use technology in a different way from previous generations (Lei, 2009), but although learner voice should have the potential to influence the way ICT is used in schools, particularly with the developments in Mobile Web 2.0 tools, there is little evidence to support this premise. Mobile phones and games consoles, tools used extensively by young people, are often banned in schools, as indeed are social networking and movie websites such as Facebook and Youtube (Sharples et al., 2009) although according to Drummond (2008) "mobile learning encourages reluctant learners by actively supporting them to experience positive learning outcomes" (p. 135).

This perceived resistance to the embracement of mobile technologies in education may in part be because of varying perceptions of learning and the notion that there is a significant difference between formal and informal learning. The difference between formal and informal learning is sometimes defined in terms of whether or not an instructor or teacher is present, or whether the outcome will be a formal award or accreditation. There is a lack of agreement amongst academics in defining these terms. Colley et al. (2002) argued that the difference is in fact

contextual and that there can be no separation between formal and informal learning and education. Indeed, Laoris and Eteokleous (2005) suggested "the advent of mobile phones presents a great opportunity and offers a timely challenge to re-define and transform our educational paradigms". However, Kukulsha-Hulme and Pettit (2007) noted that the lack of experience of mobile learning on the part of those involved in teaching or preparation of courseware was a major barrier to their adoption.

Mobile learning devices and the use of Web 2.0 tools have the potential to be used to develop learning both inside and outside formal institutions. According to Drummond (2008) "with mobile learning it is possible to engage students in activities and assessments outside the classroom. This is an effective strategy for encouraging students to interact with facilities that exist beyond the bounds of the educational environment and engage in real-life activities" (p.135). Kukulska-Hulme et al. (2009) said that not only are learners' personal interests supported through mobile technologies but that learner collaboration is also evidenced particularly outside the classroom. Arguably, if it is accepted that the boundaries between formal and informal learning are indistinct, then social networking and online gaming using mobile devices can potentially be used to develop learning. According to Conole (2008) "[there] needs to be a much closer synergy between evaluation of the learner voice and their evolving use of technology" (p. 138). This can lead to "the development of appropriate policy and strategy to create technology-enhanced learning environments" (ibid.). Thus if it is further accepted that young people learn differently using technology than previous generations, then the architecture of such mobile online learning can potentially be successfully developed by harnessing the concept of learner voice.

BACKGROUND
The research in this paper was carried out as part of the European Commission Seventh Framework Programme to develop a mobile online learning platform, exploitable on a range of internet-ready devices, and to explore their potential use with marginalised groups in an international context. Although the intention was to focus on the themes of learning and enterprise, developments were user-led with learner voice a critical element in defining the structure and attributes of the online environment.

Whilst the mobile phone was arguably the first device with potential for mobile learning using one-to-one voice communication, the current generation of internet ready mobile technologies offers greater potential for mobile learning both one-to-one and one-to-many, crossing national and international boundaries. Although ubiquitous internet access is not yet a reality, free internet access is readily accessible not only in towns in a range of cafés, libraries and public spaces but also in many rural areas and the use of mobile technologies is widely embedded in many countries and cultures. Statistics indicate that in some developed countries, market penetration of mobile phones is over 100% (Dimakopoulos and Magoulas, 2009). Of these, smart phones with ready internet access represent around a 32% share of the market (GS1 UK, 2011). Furthermore, 90% of young people aged 16 – 24 years old across the 27 European Community member states use the internet at least once a week (Eurostat, 2010) with 56% of the online European population spending an average of two hours a month using social networking sites (Block, 2007). The use of mobile games applications is also of increasing significance. This represents a growing market and currently around 22% of all applications downloaded are games. 45% of those games are played by users on a monthly basis for an average of 295 minutes (Ablott and Costello, 2011). Online gaming is particularly popular amongst young people. Around 74% of 16 to 19 year olds and 60% of 20 to 24 year olds in Europe consider themselves to be "gamers". In the UK, 70% of 16 to 19 year olds and 58% of 20 to 24 year olds play games on consoles, handheld devices or online (Ofcom, 2008). Online gaming is an example of how internet access through games consoles supports collaboration and informal learning at local, national and international level.

Countries such as the USA, Canada and Australia recognise that disengagement from school and hence social exclusion is a growing problem (Chapman et al., 2010 and Ontario Ministry of Education, 2010). Similarly, the numbers of socially excluded young people in the UK and Europe have increased steadily over the past 10 years and continue to rise despite Government intervention and targeted funding (McNally and Vaitilingam, 2007). The NEET (not in education, employment and training) figures in the UK have increased over the past 3 years, rising from 11% of 15 to 24 year olds to 13% by 2010 (Governatori et al., 2010).

Youth unemployment has increased over the past two years by 6% across Europe with 15 million unemployed young people aged 15 to 24 (Scarpetta et al., 2010). Realistically, the figures are potentially higher since statistics for categories such as transients are not available. Governments have recognised the problem of marginalised youth and high unemployment. They have developed clearly identifiable policies, which address poverty and social inclusion and are intended to break the cycle of multigenerational low attainment. Policy implementation has so far failed to achieve systemic change. Countries such as Greece, Slovakia, Romania and Italy have clearly defined social policies, but their populations have voiced concerns regarding the affordability and viability of implementing these policies (The Directorate General for Communication, 2010). Even among mainstream schools research has shown (Combat Poverty, 2004) that students from lower income groups are 5 times less likely to enter higher education than those from the highest income groups. Whilst societal reasons for this may be

multifaceted, it is evident that traditional learning structures are largely ineffective at delivering substantial change to this cultural divide. While the numbers excluded from education continues to rise it is necessary to consider how to develop learning environments that engage this group of young people in education.

Given the prevalence of the use of mobile technologies amongst young people, the potential adoption of these technologies as tools for developing learning in the hard-to-reach such as those excluded from formal education is of particular interest since Ofcom (2008) stated that socially and economically deprived young people in the UK, despite their marginalisation, are more likely to be digitally engaged than other age groups. Thus mobile web based technologies potentially offer opportunities to develop learning and employability opportunities to disadvantaged groups.

Learner voice in conjunction with the use of mobile technologies to effect educational change in marginalised groups is yet to be fully exploited. Mobile technologies and Web 2.0 tools offer an opportunity to listen to their opinions and shape their own learning in a truly personalised and engaging way. The idea of student voice is a concept of personalised learning with the focus upon young people having direct influence on their learning and the mechanisms for learning engagement rather than traditional educational rhetoric (Ruddock et al., 2006). Student voice is a notion that engages young people and values their opinions. Student voice presupposes a collective willingness to listen between students and staff, and between staff and school hierarchy, to develop bespoke curriculum and teaching methods (Seitz, 2007). Talking with students and inviting them to consult and comment on areas of learning, policy and practice provides more choices and opportunities for the learners and their facilitators (Flutter and Rudduck, 2004). Whilst those attending school have potential influence, the voice of marginalised young people is rarely heard in the same context although they are a group in urgent need of support and intervention.

METHODOLOGY
The research was gathered using an inductive paradigm and qualitative research involving an interpretive and naturalistic approach (Denzin and Lincoln, 2000). Ethnographic action research enabled researchers to gain an insight into the personal experiences and interactions of the young people involved in the study. This form of methodology builds a holistic and complex picture of the research in a natural setting. Ethnographic research relies on themes other than just observation; the principle is to interact with the participants to determine the conclusions although the potential influence of the researcher cannot be ignored completely.

Working with marginalised and hard-to-reach groups such as transients demands a flexible approach. The qualitative research methods included both individual and group interviews. These were recorded by researchers through audio, video and written notes. Observational research supported the analyses the young persons' expressions and attitudes toward the mobile learning environment. Researchers became immersed with the study to communicate with the participants, providing opportunities for extensive data gathering. Focus groups were conducted but adapted to meet the needs of this specific group of young people. Mobile devices were provided during sessions and smart phones loaned to gain an understanding of how they used these devices and what they used them for. Video was used extensively to capture their thoughts and opinions but it was noted that they did not wish to appear on camera for the most part with their faces shown. However the young people were happy to have their group responses recorded for analysis.

Quantitative data was also used to contextualise and validate the qualitative data collected. Online questionnaires were developed using a range of multimedia to negate the need for textual literacy as this was seen as potentially problematic with this group. Individuals completed these questionnaires that were available in two languages. Some were completed in group sessions and some from home by accessing a special secure login. Access to the mobile environment was monitored and usage mapped. The ComeIn infrastructure included functionality that allowed every usage of the platform to be recorded automatically for analysis, including: time spent online, videos uploaded and videos accessed. A large amount of data was available through the operational management of the ComeIn platform such as messages posted in to the group areas.

THE PILOT STUDY
Ninety-six young people took part in the research; 48 from the UK with an equal gender balance and 48 in Austria with marginally more males than females. The groups were further split in equal numbers of those aged between 14 to 16 inclusive and those aged 17 to 21. All participants in the sessions were considered to be disengaged from traditional education and were categorised as either NET (not in education or training for the 14 to 16 group) or NEET for the 17 to 21 group.

Focus groups were initially held to ascertain the type of technology used by marginalised youth across Europe, these sessions were held in Austria, Ireland, Sweden and the UK and were intended to drive the early development of the platform whilst the subsequent pilot was confined to Austria and England. A range of devices including smart phones, games consoles and iPod touches with internet access were available to those taking part in the focus groups. Internet capability provided access from these devices to various popular social networking sites,

simple games and serious games such as "Brain Training", although multi-user online gaming was not attempted. The discussions established that young people all are significant users of mobile technologies, especially mobile phones. The results indicated that the young people liked the smart mobile devices and thought that social networking using the device was satisfactory. One young person commented "I like the way you can make it easy to see" about the interface of the touch screen device (Johnson, ibid.). Whilst they were observed to play simple games at local level on the mobile devices, they appeared to dislike the features of the limited number of serious games made available to them, switching regularly between social networking sites and simple games on mobile phones as their preferred option. The young people preferred the most state-of-the-art smart phones citing usability as a reason, and comparing them to the larger computer-based devices. In addition to social networking sites, the young people stated that they used video sharing sites such as YouTube on a regular basis. This suggested the potential of video in conjunction with mobile technologies as an aid for reintegrating the young people back into education or work.

Figure 1. ComeIn Focus Group Session (Johnson et al., 2009)

A simple online environment was built which reflected the opinions and comments of the young people. The environment could be accessed from mobile devices using 3G or wireless and from stand-alone computers. The input of the young people was used to further refine and build the environment for the duration of the pilot. Technical developers worked within the environment to gather direct input from the young people. Thus learner voice became an integral part of the project defining the mobile learning environment from inception to the end of the pilot. The design and the content of the platform were thus defined by the participants themselves to suit their needs. Because of the short timeframe, it was not possible to build all the desired features into the platform. Evidence from Shim (2008) suggests that access to social networking sites and online communities is determined according to the ethos and the culture of the site. For example, there was no opportunity to create a personal profile, a feature considered to be essential by the young participants. This was reflected in the results of the focus groups where young people said that there needed to be a definitive purpose for them to participate in these sites. They argued that they should be able to present themselves to the community using a profile page and photo albums although it is noted that internet safety guidance (Byron, 2008) actively discourages this.

From the discussions at focus groups, conceptual guidelines were developed which were embedded into the development and design of the platform. The guidelines provided a foundation for creating a successful mobile online learning community for marginalised young people. They included: having a sense of purpose, active meaningful participation, appropriate code of conduct, innovative technology and tools, suitable user friendly design, element of trust, user defined roles, subgroups for discussion and distinguishing identity (Johnson et al., 2009). The low literacy skills of the group were not found to be a barrier to facilitate social inclusion as the platform was icon driven. Interestingly, cross-cultural communication was observed between Austrian and British young people despite the expected language barrier.

The customisable web interface developed for the pilot project following analysis of data from the focus groups and questionnaires is shown in Figure 2. As indicated above, the interface is not only icon driven but also has

simple navigation tools as the participants said that this feature would encourage them to actively participate. Figure 2 shows the platform, with the latest news, videos, groups and messages on an individual's customised homepage. The users navigated through the learning environment using the three icons across the top of the homepage to access groups, videos and their "friends list".
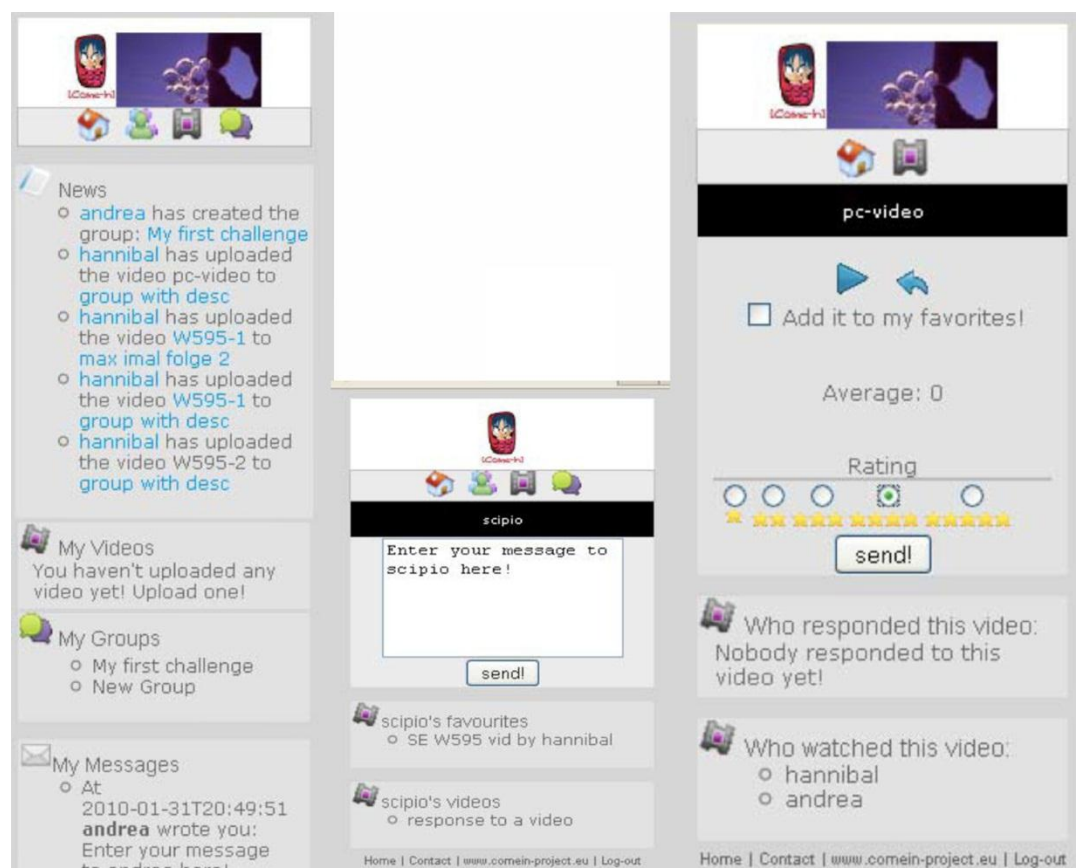
Figure 2. ComeIn interfaces (de Vicente and Pascual, 2010)

In order to further develop the web environment into a useful tool for learning, an online questionnaire was designed to ascertain the opinions of the young people concerning the skills they considered important and necessary for their future employment. The questionnaire allowed them to rate their existing competencies as well as highlighting their perceived needs. Learning materials available in the environment were developed around these results with the aim of helping the young people to develop the competencies needed for their future career. The analysis of the data indicated that the young people felt they already had basic ICT skills and did not require ICT training in contrast to what is highlighted as part of the core school curriculum in some countries. The results also suggested that the young people considered that they needed to improve functional literacy and numeracy skills as well as some identified core employability skills. Observational analysis at focus group events supported the findings of the analysis of the online questionnaire conducted earlier. Some learning materials were developed to provide interest and structure to what would otherwise have been an empty shell, but young people were actively encouraged to post materials as soon as possible. To improve employability skills, for example, short video clips were made which covered issues such as interview technique and dress code. Actors were amateurs drawn from the target group, providing plausible role models. Young people were then encouraged to view, rate and comment on the videos within the platform, so that learning objectives became discussion points. This level of dialogue also served to encourage the young people to make their own short movies for submission to the site. The young people uploaded 550 videos during the pilot. Moderators were able to engage in developing literacy through comment and dialogue within user groups and through seeded discussion about the multi-media posted in the area. Outcomes could then be mapped against the criteria for formal awards. In the UK, for example, outcomes fit the Level 1 IT Users Certificate, aspects of Literacy including Reading, and Level 1 Employability Skills. Each of these carry credits on the National Framework. All interactions with the young people were recorded on a database, not only from the platform but also from any dialogue or text messages, so that an accurate assessment record of their learning could be maintained. At this pilot stage, numeracy was less developed and although some work was done by encouraging the use of rating and scoring systems by young people, not a great deal of specific targeted numeracy material was developed within the system. However, it soon became clear that young people were very adept at functional numeracy where it

concerned their use of mobile phone credit, downloads and texts. In other words they were soon able to demonstrate the ability to understand simple problem solving at a practical level and negotiate practical solutions.

Of the 96 users, only two dropped out. Two had equipment stolen and participation was curtailed. The remaining 92 young people logged on to the learning platform for the duration of the pilot and the full range of features of the platform were regularly utilised. The average participant uploaded 5.73 videos during the three-month pilot. The average time spent on the platform per user was 7.3 hours; in comparison UK users of Facebook spent an average of 7.5 hours per month (The Nielson Company, 2011). 318 text messages were exchanged. Young people instigated 67 of the 92 user groups on a range of topics. For the most part, users accessed the community using smart phones rather than other mobile devices such as games consoles. This needs to be viewed in the context of around 30% owning games consoles although all were loaned smart phones for the duration of the pilot. Participants were allowed to retain the mobile phone at the end of the pilot and were observed to personalise the devices as the project progressed.
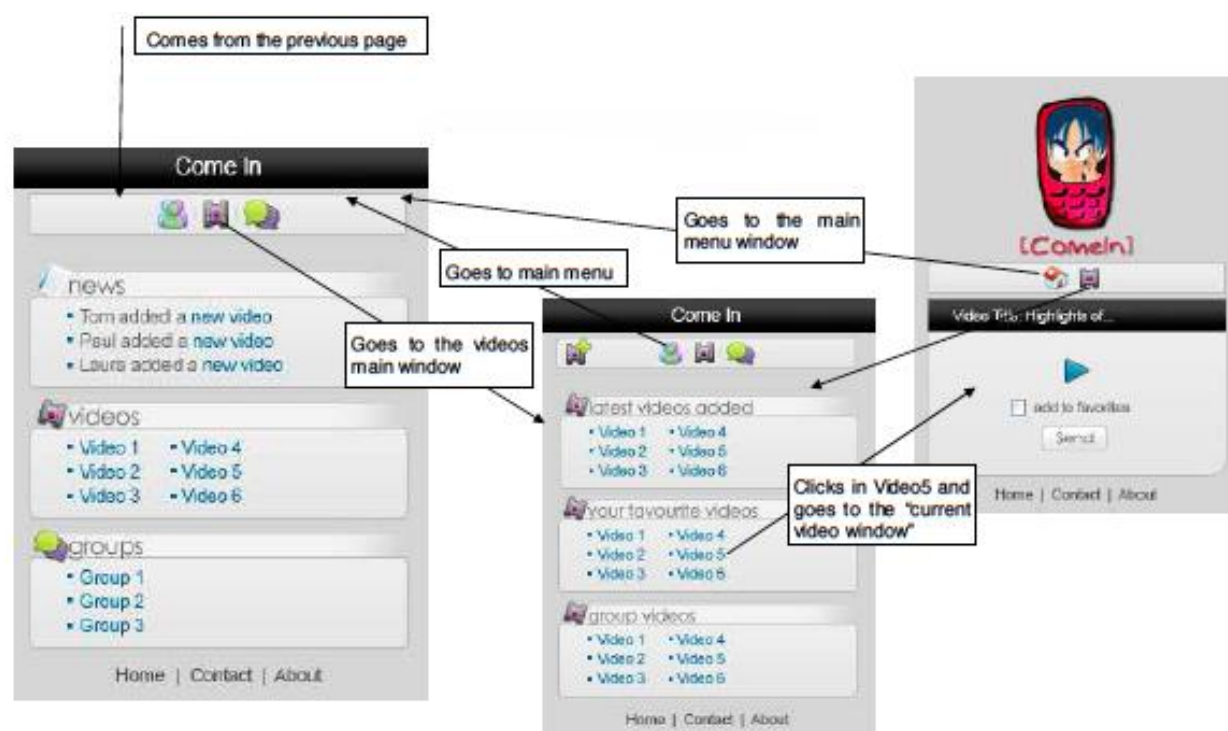
Figure 3. Design of ComeIn platform

CONCLUSIONS

The current world economic recession has exacerbated the unemployment crisis for youth in general and demographics have altered the demand for unskilled labour in developed countries. Nevertheless, statistics indicate that disaffection by youth from formal institutionalised learning is a growing trend despite government intervention. Low educational attainment is closely linked to unemployment, crime and poverty, limiting social mobility. This is a significant cost to the economy. Education is perceived as a key driver for social mobility whilst identity capital comprising educational, social, and psychological resources is at a premium where entering the labour market and maintaining employment is concerned.

Whilst policy makers have failed to reverse the trend for disengagement and marginalisation amongst young people, this research suggests that learner voice offers a potential solution to support the development of mobile learning using internet enabled mobile devices and Web 2.0 tools. The potential for using mobile platforms combining facets of social networking and online communities of practice offers previously unexploited opportunities for working with marginalised groups and enabling their entry to the employment market as net contributors to the economy through the use of emerging, immersive, adaptive, pedagogical approaches. However, where marginalised young people are concerned, technology integrated into a learning environment needs to reflect the thoughts and opinions of the audience to encourage active participation for an extended period. Learner voice offers an opportunity to develop online communities of practice and serious games which reflect the needs of marginalised youth and offer an opportunity for them to develop the skills for lifelong learning which they themselves consider to be important. However, the attitudes of staff and trainers within institutions appears to be a

barrier to these developments, partly because of the way they perceive formal and informal learning and partly because of their own use of mobile technologies which is likely to be more limited than that of young people.

RECOMMENDATIONS

The pilot study itself was of only 13 weeks duration and whilst useful conclusion were drawn, a lengthier study would be expected to provide more robust results. The prototype platform itself had limited functionality because of budgetary constraints and limited development time. Extending the prototype in conjunction with an extended study would potentially provide valuable data. However, given potential budgetary constraints, there are two feasible options to employ. Either the existing platform could be further developed or existing widely used social networking sites could be explored and functionality mapped against the requirements of the target group of young people. If relatively close mapping could be determined, this could provide a more realistic option providing the platform has sufficient flexibility to allow learner voice to determine further development. Although internet enabled games consoles formed part of the study, their exploitation in terms of learner voice was limited and insufficient data gathered. Further research would be useful in terms of their potential for learner defined games architecture and how their use can be integrated with smart phones to exploit the interests of young people in a meaningful way to progress learning. Furthermore, it is possible that were schools to use the concept of learner voice to develop their policies surrounding pedagogies and mobile technologies with those who had dropped out, or were at risk of dropping out, the numbers of NEETS could possibly be reduced. This however would need to be the focus of further research.

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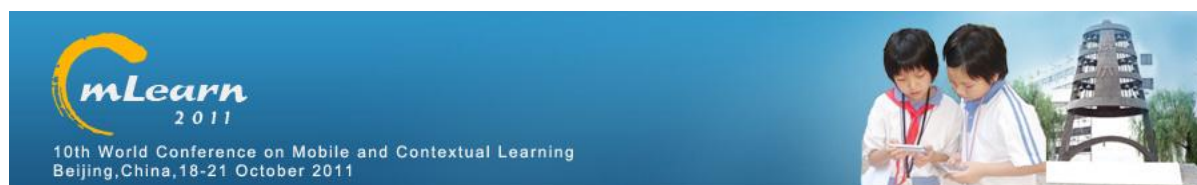
Context in our pockets: Mobile phones and social networking as tools of contextualising language learning

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ABSTRACT

The analysis of current EFL (English as a Foreign Language) education and literature indicates that most EFL practices can be characterised as traditional language learning settings in which teachers direct the learning process, and students are then assumed as passive receptors of knowledge. Furthermore, EFL learning has also been criticised as an in-class-only learning practice due to the rare opportunities an EFL learner is expected to encounter outside the boundaries of the classroom. These limitations of EFL learning could be addressed through more student-centred, meaningful, and contextualised language learning that extends beyond the boundaries of the classroom. Mobile technology and social networking have the potential to establish learning practices that are not only based on learners' needs and experiences, but they can also involve learners in the overall learning process that sometimes goes beyond the classroom. In addition, much of the literature on mobile learning emphasises the effectiveness of mobile technology in creating contextually meaningful and authentic learning opportunities. A DBR (Design-Based Research) study was conducted with 33 EFL university students over a 16-week semester. Students experienced a contextual learning experience using Facebook via their mobile phones. The paper concludes that mobile social networking media, e.g., Facebook, provide rich learner-generated and contextual out-of-class language learning opportunities that exploit the norms of the learning context. Moreover, mobile Facebook provided students with reality-based learning experiences that utilised their own knowledge and personal values about their context.

Author Keywords

Mobile language learning, mobile social networking, user-generated content, contextual learning, design-based research

INTRODUCTION

Most EFL (English as a Foreign Language) contexts have been characterised as traditional language learning settings in which teachers direct the learning process, and students are then assumed as passive receptors of knowledge (See, e.g., Al-Hazmi, 2008; Chen, 2007). In addition, EFL learning has also been criticised as an in-class-only learning practice due to the rare opportunities an EFL learner is expected to encounter outside the boundaries of the classroom. This indicates the need for practical incorporation of a student-centred approach and contextualised language learning. Thus, mobile technology is examined here as a means to enhance different student-centred practices and to create meaningful outside-classroom and contextualised learning opportunities.

Current practices of mobile learning are not theoretically guided, but rather, they are deemed to imply paradigms that are sometimes technology-driven, rather than pedagogy-based (Naismith, Lonsdale, Vavoula, and Sharples, 2004; O'Malley, Vavoula, Glew, Taylor, Sharples, and Lefrere, 2003). Hence, context-awareness is one of the rich aspects that can be enhanced by mobile learning in a way that exploits the affordances of mobile technology used outside the classroom in an exemplary way. Mobile learners, for instance, are now able to interact and communicate with the context in which a mobile learning task is taking place. Unfortunately, mobile language learning has not yet used an evidence-based research approach to adequately explore the context-awareness paradigm. Evidence is required to understand how mobile language learners interact with their surrounding environment and exploit the functionalities of their mobile phones to better realise the potential of out-of-class learning. Moreover, concepts of student-centred learning as well as mobile

social-networking and collaborative learning have not yet been adequately investigated by mobile language learning research.

Using a DBR (design-based research) approach, the current paper tested, redesigned, and then refined learning designs to establish and then account for contextual implications for mobile language learning. The design involves reflections and feedback of EFL learners.

The paper also investigates the potential of mobile phones in maintaining effective learning environments, and to explore whether mobile phones can assist language learners in establishing a collaborative mobile medium that takes advantage of students' familiarity with the use of mobile phones, on the one hand, and social networking environments such as Facebook, on the other. The integration of mobile phone technologies into tertiary education holds both opportunities and risks for the quality of mobile learning (see Kukulska-Hulme, 2005; Kolb, 2008). As a result, it is essential that a better understanding is gained of learners' perceptions and attitudes towards the implementation of mobile phones in language learning.

LITERATURE REVIEW

The Potential of Student-Centred EFL Learning Design

As previously discussed, most EFL learning opportunities are usually classroom-based and/or teacher-centred rather than focused on students and their needs inside and outside of the classroom. However, there has been a growing interest in updating theoretical assumptions and new educational approaches and methods that can maintain effective learning, particularly, under collaborative, authentic, and meaningful conditions (Hu, 2002).

According to Levy and Stockwell, (2006), the move toward student-centred approaches was an attempt to gain a better understanding of students' backgrounds, roles, and perspectives. Student-centred approaches, as also noted by Hu (2002), are the most significant innovations in language learning that help students acquire communicative competence to meet their needs, and to engage them in purposeful communication in meaningful contexts. Students in turn are expected to "react to, reflect on, and make creative use of the information provided by the textbook and the teacher to engage in stimulating tasks and activities" (Hu, 2002, p. 40). However, this theme of personalised learning can also be broadened to deal with other dimensions of learning beyond the roles of teachers and textbooks. For example, self-regulated learning approaches (Chang, 2005), student-generated learning approaches (Kukulska-Hulme, Traxler, and Pettit, 2007), and self-directed learning approaches (Nah, 2008) have been developed. Students themselves can become co-collaborators in the design of their learning experiences. For example, Levy and Stockwell (2006) argue that students with educational technology can play an important role in the design process if they were given the opportunity, and can then develop or review learning strategies and share with one another. Therefore, it is the learner's own responsibility for decision making and autonomy, which is integral to student-centred learning approaches.

Computer and internet technologies have been frequently used in language learning contexts to enhance student-centredness, students' engagement, interaction, and collaboration (Nah, 2008). More importantly, mobile learning as well as social media, e.g., Facebook, enable interactions between students both beyond and within their own institution and can effectively maintain student-centred learning environments (Fisher and Baird, 2007; Sharples, Taylor, and Vavoula 2005).

The Potential of Contextualised Out-of-Class EFL Learning

Effective use of students' out-of-class time, as Kennedy and Levy (2009) note, is a basic goal of recent computer-based language instruction, particularly in a university environment, where in-class language practice time is limited. When an out-of-class practice is targeted, Kennedy and Levy (2009) continue, limited in-class time can be dedicated to face-to-face communication and useful guidance for students on how to exploit out-of-class learning opportunities and to "support students' development as independent strategic learners" (p. 449). Technology can also be integrated to provide EFL learners with authentic and meaningful dialogic engagement with contextual elements of an out-of-class learning environment (Shin, 2006). Indeed, technology can be used to engage language learners with broader communities and local and international cultures and enhances their sense of community by participating in the community outside the classroom (Reinhardt and Nelson, 2004). Examples of technological tools that can provide rich out-of-class learning opportunities for EFL learners include email (Torii-Williams, 2004), blogs (Comas-Quinn, Mardomingo, and Valentine, 2009), podcasting, (Ducate and Lomicka, 2009), and mobile technologies (Kolb, 2008; Kukulska-Hulme, 2009).

The internet technology has been found to be helpful in the assimilation of local cultural elements within EFL contexts (See, e.g., Al-Jarf, 2004; Torii-Williams, 2004). The integration of mobile technology, particularly, for contextualising language learning is potentially valuable. The sheer mobility of mobile technologies enables student interaction with such a wide range of location-based contexts. Mobile phones, for example, can effectively connect between the culture of student home life and student experiences, and can integrate home

cultures of students into their classroom learning (Kolb, 2008). Furthermore, mobile phones can bridge the divide between the technologies students use at home and what they use in school (Prabhu, 2010). Besides, the mobile generation, i.e., current young students have developed extensive social communities outside the classroom that can be harnessed for contextually-based out-of-class EFL activities.

Mobile Learning and Context-Awareness

According to Pham-Nguyen, Garlatti, Lau, Barby, and Vantroys (2008), context-aware learning takes place when there is a combination of formal and informal learning in broader educational scenarios and different contexts, in which a learner successfully interacts and selects from adaptive resources. In this regard, mobile phones, as Naismith *et al.* (2004) point out, are particularly "well suited to context-aware applications simply because they are available in different contexts, and so can draw on those contexts to enhance the learning activity" (p. 14). However, learning with mobile phones is not intended to make artificial mobile settings and push learning opportunities into them, but rather, it is to take advantage of "being mobile" to enhance learning.

Theng, Tan, Lim, Zhang, Goh, Chatterjea, Chang, Sun, Han, Dang, Li, and Vo (2007) implemented a context-aware procedure with secondary school students to help them to learn about climate elements such as temperature, rainfall, humidity, and air pressure in a geographical fieldwork study, in which students were trained to use their PDAs before going to certain locations using a geographical platform. Such illustrative systems, as cited in Carter (2009), are aimed at facilitating the acquisition of abstract knowledge in a meaningful and motivating way. Most importantly, it can be argued that location-based geography learning and similar out-of-class learning tasks are exclusive to mobile learning.

For language learners, the varieties of authentic location-based environments are almost limitless and offer significant opportunities for language learners to acquire linguistic and communicative skills meaningfully and in real contexts.

Mobile Language Learning and Authentic Learning

Petersen, Divitini, and Chabert (2008) considered a socio-constructivist authentic language learning approach to mobile language learning. Their learning design was highly supported by collaboration, interaction, and developing a sense of community through mobile community blogs, particularly when students were physically present in the target language setting and culture, and/or when they were away from their classmates. The study by Petersen *et al.* (2008) revealed that mobile blogs were effective tools that facilitated student-student interaction in different language settings and created authentic opportunities for students to interact with native speakers. However, the researchers found that participants' sense of community and belonging to the language learner community was not high, and participants' identity was not well identified. Researchers attributed this to the lack of identity among members as a community and believed that the blogs were incapable of strengthening new, rather than existing communities. It was also found that participants were not eager to collaborate in the mobile blog due to hesitation and lack of confidence among students. For the current paper, however, it is important to point out that sense of community and belonging to the learning context among students were high, and that students were keen to engage in authentic learning activities outside the classroom. As discussed subsequently, a positive sense of community and belonging can be attributed to students' familiarity with the learning context and the learning community as well.

METHODOLOGY

DBR and Mobile Language Learning

Design-based research can be defined as "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Wang and Hannafin, 2005, p. 6). Five fundamental characteristics of design-based research have been proposed by Wang and Hannafin (2005): grounded (in both theory and the real-world context), interactive, iterative and flexible, integrative, contextual, and above all pragmatic. The pragmatic characteristic of design-based research evolves from solving real-world problems by designing and practicing educational interventions (solutions) as well as extending theories and refining design principles through continuous cycles of design and redesign. Most importantly, design-based research does not merely implement and test particular designs and interventions, but rather, it can contribute to learning and teaching theories (Design-Based Research Collective, 2003).

Based on the fact that mobile learning does not rely on a specific learning theory or approach due to its relative novelty, and that most current practices of mobile learning are teacher-driven rather than based on students' experiences and beliefs (Kukulska-Hulme, 2009), DBR can potentially address these limitations of mobile

learning. Table 1 illustrates how the five characteristics of DBR (See, Wang and Hannafin, 2005), can be applied to research in the mobile language learning situation addressed in this paper.

Characteristics of DBR	Implications for research into mobile language learning
• Grounded in theory and real-world context	• Theory: student-centred /out-of-class context-aware mobile language learning • Practice: student-generated content and students' as co-contributors to the design
• Interactive, iterative and flexible	• Teachers and students interact with and input into iterations of mobile language learning designs • Mobile language learning tasks go through analysis, design, implementation, and redesign using various pedagogies • Alterations can take place *when* and *where* necessary
• Integrative	• Mixed methods are used e.g. analysis of mobile blogs, mobile quizzes, interviews, etc. • Mobile language learning is integrated with the curriculum and blended with other technologically-enhanced learning
• Contextual	• The research and implementation of context are taken into account when evaluating findings of the current design • Findings and changes of initial research are documented and then connected with the mobile design and the setting
• Pragmatic	• DBR defines and/or refines optimal practices for mobile language learning

Table 1: Characteristics of DBR (Wang and Hannafin, 2005) and their implications for mobile language learning

This research enquiry explored the following question: What are EFL students' perceptions of the effectiveness of mobile learning for:

    a. establishing meaningful contextually-aware language learning designs? and
    b. connecting in-class with out-of-class EFL learning?

Research Design

This paper examines the usefulness of mobile phone technologies for creating communicative, student-centred, and authentic language learning conditions that go beyond traditional EFL classrooms. It is also designed to evaluate the potential of the implications of DBR for mobile language learning. Further, as opposed to typical teacher-generated learning designs, this paper invites students, as co-collaborators, to contribute their voice, experiences and perceptions to the iterative design cycle.

The study was conducted over a 16-week semester using qualitative methods. Research tools included focus group interviews, Facebook observation, analysis of students' feedback and reflection, and stimulated recall sessions. The study was conducted with 33 EFL university students studying Bachelor of Education with a major in the English language at King Khalid University, Saudi Arabia. Students were enrolled in a Vocabulary Building course, in which they were studying Academic Word Lists and doing intensive vocabulary exercises. For most students, the study was the first language learning experience that required them to reflect on their own contexts, and to imply that into their learning activities. In addition, students indicated that mobile Facebook was not utilised in their previous learning.

Procedure

Ten randomly-chosen students were interviewed before the task in order to identify any difficulties they might have encountered while learning English, and to reflect on the current design of the study. Over three days in a week, all students were scheduled to upload multimedia materials (photos or video clips) from their own contexts to a Facebook group using their own mobile phones. Students were expected to reflect on each other's uploaded materials using their mobile phones as well.

Students were informed that uploaded materials should be associated with captions, descriptions, or starter questions to the discussion board created by the uploading student. Materials also should reflect some social occasion or event that occurs out of class, or have some local or cultural characteristics. Specifically, captured materials could be something that other students may not be aware of, provided that participants are believed to have relatively different cultural backgrounds and customs. Other participants in the group, who will be automatically notified of the new thread by Facebook SMS service, will be required to respond and comment on those uploaded materials with 5 comments and 3 responses as a minimum for each participant over the six week duration. The researcher's role in this activity is to facilitate discussion and to provide guidance when needed. Moreover, both the students and the researcher have to identify, from the discussion, elements that have linguistic characteristics that could benefit language learning. The group also have to connect between in-class

linguistic activities and Facebook contextual topics. In other words, the Facebook material and discussion board content from the week prior will be integrated back into in-class discussion.

This learning scenario lasted for six weeks (first iteration of the learning design), during which students' Facebook interaction was observed and analysed. After the first iteration was over, a stimulated recall session was conducted with five students to identify a rationale for students' Facebook interaction and the integration of cultural and contextual norms into their learning experience. Stimulated recall session also aimed to draw out students' reflections on the design, and what needed to be improved for the second iteration. An initial data analysis was conducted before the second iteration commenced.

The second iteration lasted for another six weeks and repeated the process detailed for the first iteration. After the study was over, another randomly-chosen ten students were interviewed to explore their experiences and perceptions toward the use of mobile Facebook in their language learning.

RESULTS

1. Pre-Task Focus-Group Interview

The pre-task focus-group interviews aimed to elicit students' own conceptualisation of context-awareness and whether there had been any impact of local and contextual norms on their learning experience. Although most students argued that they did not have rich opportunities to extend their learning activities beyond the classroom, some mentioned that there were some limited contextual elements being used in some other courses. Students indicated that they have few opportunities to write or speak about local situations. Overall, a student argued that only 20 to 30 percent of in-class activities are connected to the out-of-class environment. Another student suggested that their college studies should involve extracurricular visits to places where English is spoken. This discussion raised students' curiosity about the impact of the integration of mobile phone technologies and Facebook on connecting in-class learning with external contexts. This was clear from questions that were raised by students during the interview inquiring about their upcoming task.

2. Facebook Observation

It was noticed that students who already had Facebook accounts were more active than those who just signed up for Facebook. Consequently, more active students were scheduled to post their threads before less active students, so that less active students were targeted to learn how to communicate effectively through Facebook by their active counterparts.

The observation of Facebook interaction and uploaded materials indicated that most threads were taken from students own contexts (cities, villages, etc) and contained unique landscapes, cultural folklores and dances, festivals, family gatherings and parties, and even incidents like floods. Moreover, it was clear from comments that the majority of uploaded materials were interesting for most of the group members, while a few threads seemed familiar to the group. Also, there was a rich contextual discussion using language that reflected the out-of-class environment.

As time went on, students started to collaborate on irrelevant casual topics that had nothing to do with the course especially on weekends. Relevant topic threads and discussions were active during the weekdays particularly in the evening or after classes. It was also noticed that students' interaction increased dramatically during mid-term exams and before finals. Students were, at these periods, sharing ideas about their exams, inquiring, and asking for some clarifications from their teacher.

3. Stimulated Recall Sessions

The stimulated recall sessions sought students' evaluation of the first iteration of the learning design. Overall, students appreciated the implementation of mobile phones and Facebook to connect in-class activities with the external context. They also liked the incorporation of contextual norms from their own environments to their learning task. Students also indicated that they even learnt about surrounding places that they were unfamiliar with. In an interviewee's words:

> After [a student] uploaded a video clip about his hometown, I visited it the next day. I had no idea about it [hometown] before, and I did not expect it to be like that. I actually thought [he] fabricated the video clip [laughing] so I decided to go there.

Although the role that mobile phone Facebook played in learning contextualisation, students listed some limitations that they encountered during their learning task. Some of the limitations included the lack of good network coverage especially at remote areas, the interference between learning and non-learning materials on Facebook e.g. ads, and the tendency to use the first language in certain situations. In addition, some students indicated that they were in favour of browsing Facebook from their computers rather than their mobile phones. Students attributed this to the small screen size and small keypads of mobile phones compared to computers.

Unlike the fast local internet connections for computers, slow internet connections for mobile phones were also a limitation for some students.

4. Adjustment to the Design

Based on students' reflection on the first iteration of the design, some adjustments were made in the design and then applied in the second iteration. Major adjustments included:

1. Students were free to post their own threads whenever they got something worth sharing. Students in the first iteration were scheduled to a timetable (three students a week).
2. Uploaded materials could be text-based. Materials in the first iteration were only pictures or video clips.
3. Students could use their computers to upload large-size learning materials to Facebook. However, uploaded photos and videos should be captured by mobile phones.
4. Uploaded materials should recognise diversity, differences, and individualities of students. Such issues were less of a focus in the first iteration.
5. Students should look at the linguistic side of the learning materials they want to share. For instance, a student should elaborate on the linguistic content of what he has uploaded given that not everyone in the group was familiar with it. The teacher's role here was to highlight these linguistic elements and to match them effectively to context.

5. Post-Task Focus Group Interview

Another randomly-chosen ten students were interviewed in the final week of the semester. The post-task interview investigated their experiences and perceptions toward the use of mobile Facebook in their learning. The interview also examined students' context-awareness in their language learning experiences and whether they benefited from the process of contextualising their EFL learning via Facebook and mobile phones.

The interviews showed that students valued the implementation of mobile phone Facebook in their learning task. Students, for example, indicated that mobile phone Facebook not only provides them with collaborative tasks in real-world settings, but it also created, for them, meaningful and authentic learning opportunities beyond the classroom. Students also stated that Facebook helped them to become familiar with each other, something that would not have occurred without such an interactive social networking tool. Additionally, a student argued that Facebook provided them with friendly channels to communicate with their teacher, which were not available to them via other learning online tools such as Blackboard.

DISCUSSION

Despite the fact that students in the study were accustomed to latest trends of instructional technology provided by their institution including Blackboard, mobile phones as well as mobile Facebook assisted students more broadly to find ways of learning that fit with their mobile lifestyles and out of class hours. This is the key distinction, as proposed by Kukulska-Hulme (2009), between computer-assisted and mobile-assisted language instruction. Moreover, the utilisation of informal social media such as Facebook increased students' engagement in the learning task, and motivated them to implement contextual elements from their own environment. In addition, the integration of local cultural norms into the learning design assisted students to collaborate with each other in the target language.

Thanks to mobile phone technologies, students developed their own interests and abilities to create learning resources that reflected the learning context and students' own choices. Most importantly, the utilisation of tools that students were already familiar with, i.e., mobile phones and Facebook, played an important role in maintaining a positive sense of community and authentic learning opportunities outside the classroom. Thus, it is important to point out that the implementation of learning tools, that students are already accustomed to, saves both students' and teachers' time, and does not require additional training. This study, for example, implemented two intensive iterations of a learning design inspired by DBR approach over one semester, where it was hard to dedicate time for training. However, students attended an introductory session during the first week of the semester to ensure that they were all familiar with the functionalities of their mobile phones and/or Facebook.

As far as student-generated content was concerned, the current paper draws out what the learning context offered to students in ways that allowed them to create meaningful learning resources via their daily interaction with the external environment. Student-generated learning content did not only support collaboration and a community of practice among students, but it also fostered their individual creativity and competitiveness. Kukulska-Hulme *et al.* (2007) describe such user-generated activity as mobile-based cultural citizenship activity,

in which students involve everyday life situations in their learning and transform that into engaging learning experiences.

The contextualisation of this language learning setting helped students to develop more sophisticated skills beyond the learning task itself. For example, students learnt how to think critically about certain issues and to justify local incidents particularly in the target language. Each student was required to analyse what his classmates uploaded to Facebook and to find strong connections between in-class and out-of-class activities. Above all, students' decision-making skills improved by enabling them to provide critical feedback on the learning design, and allowing them to see the influence of their feedback and reflection on the adjustment made on the design.

The role that mobile learning can play in enhancing contextual and authentic learning practices has been addressed by several researchers (See, e.g., Herrington and Herrington, 2007; Kukulska-Hulme, 2009; 2010; Kukulska-Hulme *et al.* 2007). Arguments outlined by these researchers are supported in the current paper. Mobile phones and mobile Facebook provided EFL students with rich contextual opportunities that extended beyond the classroom. Mobile learning not only stimulated collaboration and interaction between students, but it also enhanced their context-awareness about their surrounding environment. Moreover, students collaborated on interactive learning tasks through which they connected in-class learning activities and language items with the external context and created from their class group a mobile learning community. In other words, students successfully incorporated some outer contextual topics that reflected their own environments into their classroom discussion by the means of mobile social networking.

CONCLUSIONS

This paper reflects on what mobile phones and mobile social networking tools such as Facebook can offer to improve language learning and EFL education. It presents a summary of pedagogical uses of mobile phones and mobile Facebook in creating contextual and authentic language learning settings.

According to Cochrane and Bateman (2010), the process of "immersing students within a social constructivist pedagogical environment can be a new and challenging experience for the students, therefore implementation requires planned staging and scaffolding to support student learning" (p. 12). Hence, a social learning environment using mobile phones and mobile Facebook was adopted. The adoption of a DBR approach was basically aimed at providing flexible learning environments that recognise students' voices and cater for the transformation from a traditional EFL learning condition to a more collaborative and contextual learning experience. It was also intended that students should exploit what already was available to them to facilitate this transformation, i.e., mobile phone technologies and Facebook. Traditional language learning settings, as Nah (2008) found in his study, provided students with limited in-class input opportunities, whereas students obtained more frequent comprehensible input opportunities using their mobile phones whenever they needed to.

In the current study, students were effectively engaged in two iterations of the learning design inspired by DBR. Students' voices were also crucial in the cycles of design, implementations, analysis, and redesign. Both iterations were refined and students were able to experience every bit of the design adjustment. In each iteration, qualitative data revealed findings about the effectiveness of contextualising language learning facilitated by mobile phones and mobile Facebook. Although several parts of the design remained relatively stable over the two iterations, other parts have changed based on students' feedback.

It seems that future EFL students will lead their mobile learning initiatives by creating their learning content and resources and manipulating their mobile social interaction. However, future mobile language learning designs should consider students who might be unaware of the potential of their mobile phones for learning. According to Dede, Nelson, Ketelhut, Clarke, and Bowman, (2004), an important emphasis of the adoption of DBR is to improve students' academic achievement, motivation, knowledge, and skills. Thus, researchers of mobile language learning should take these fundamental issues into consideration. Future research should also focus on students with special needs and those who are not keen to use their mobile phones and/or their private social networking spaces for learning purposes.

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Views on the role of mobile phones in post-training support in South Africa

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ABSTRACT

The Department of Health of South Africa recently initiated an ambitious training project to address the high level of youth unemployment. This project aims to provide a total of 3535 unemployed youth with the skill set to succeed as data capturers working in health facilities nationally. In this research, we discuss the results of the analysis (including data mining) of data from questionnaires, as completed by the trainees involved, in order to obtain a deeper understanding of their typical profiles and mobile phone usage patterns. The results confirm findings from existing research and relate to gendered uses of mobile phones and factors in the rural-urban mobile phone divide in developing countries. Valuable pointers are identified towards more focused research on the rural-urban mobile technology divide, which might contribute to a better understanding of the complexities at play in constituting this divide.

Author Keywords

Mobile post-training support, mobile learning, gendered uses of mobile technology, rural and urban mobile technology divide, health informatics, data mining

INTRODUCTION

This study forms part of ongoing research on the so-called "3535 project". The critical need to improve health information in South Africa gave rise to the Basic Routine Health Information System for Data Capturers (HISDC) project. This project involves the training of 3535 unemployed youth as Data Capturers over a period of three years. The National Department of Health (NDOH) identified the need for such a project in February 2007 where after a task team was formed to develop a concept document. In April of 2007 the concept document was adopted and added to the Presidential Priority List for the EPWP (Expanded Public Works Programme).

The aim of the Basic Routine Health Information System for Data Capturers is not only to improve health information across South Africa but also to secure the Human Resource supply in the public health sector. In achieving these aims the project also provides unemployed youth with the opportunity to obtain invaluable training and working experience.

In November 2008 the NDOH awarded the tender for the 3535 project to the services of a collaborative team (the training provider); namely Health Information Systems Programme (HISP), Health Systems Trust (HST) and Continued Education at the University of Pretoria (CE at UP). The training programme involves 21 days of full time training at the Hammanskraal Campus of the University of Pretoria for groups of approximately 140 trainees. The training covers computer literacy and Health Information Systems.

After the completion of the training, trainees are transported back to their rural and urban health facilities to serve as data capturers for the remainder of their one year internship with the eventual aim of becoming full time employees. As part of the agreement between the client and the training provider, post-training support has to be provided.

In terms of the tender specifications, the post-training support for this project was to be done telephonically and a share call facility was set up for this purpose. In addition the training provider offered to provide mobile post-training support as an "add on" to the helpline support originally specified by the Department. Another study done on this project, (Matthee and Liebenberg, 2011) describes the successful adoption of the mobile platform by the earlier groups (up to 2009), to such an extent that the landline support was terminated.

Mobile support is done via the open source mobile platform Mobile Learning Engine (MLE) and linked to this is a targeted SMS service. For the project implementation, the MLE client was renamed MOBI and adapted by changing icons and adding functionality. The reasoning behind the consideration of the mobile support option was the fact that South Africa has an extremely high cell phone penetration (above 95%).

BACKGROUND

The mobile post-training support is considered successful. This is illustrated by the extensive use of the Frequently Asked Questions section, the access of the learning content and the creation of chat groups (Matthee and Liebenberg, 2011). Part of the success is ascribed to the preparation of the trainees while in training to use the mobile platform. One session is set aside for this purpose and during this session, students complete a questionnaire which enables the training provider to determine the "digital literacy" of the trainees. It is important for the training provider to understand the background of the different groups, their access to technology and their cellphones' capabilities. Questions are therefore asked on access to mobile technology, access to technology at the clinic, access to the Internet, the capabilities of their phones and the uses of their phones. Two open ended questions are included, one where the trainees' expectations of the post-training support is determined, and one where they need to describe the role they think mobile phones will play in the post-training support. Apart from this, data is captured on the trainees' gender, province, rural or urban area from where they come as well as their age category. During this session trainees are provided with airtime vouchers. They are also shown how to choose the best option for their particular handset.

Although not the purpose of the questionnaire, we decided to explore the relationships between the different variables captured in this questionnaire. We used a single group that was trained in January 2011. The group consisted of 137 trainees from Kwazulu Natal, the Eastern Cape and the Western Cape provinces of South Africa. The next section shortly describes the approach that was used after which the findings are discussed.

RESEARCH APPROACH

As stated above, our goal was to determine whether there were any novel, surprising trends in the data, which could further our understanding of the trainee's profiles, mobile phone usage patterns and expectations. We proceeded to analyse the data following knowledge discovery from data process (Han and Kamber, 2009). In addition to this, we used simple frequency distributions to follow up on leads provided by the data mining results. Knowledge discovery is a three step process, involving preprocessing the data, applying data mining algorithms, and presenting the final results to the users. For these experiments, we used the WEKA data mining software which contains numerous data mining algorithms (Witten and Frank, 2005). We proceeded as follows. We firstly preprocessed the data, followed by applying a number of data mining algorithms and the analyses of our results, as discussed next.

Data Preprocessing

For a data mining exercise to be considered successful, it is essential to obtain an initial overview of the data and to ensure that the data set is of high quality. Data preprocessing entails descriptive data summarization, possible data cleaning, data transformation and data reduction. In this case study, it follows that the quality of the data depends on the truthfulness of the participants and we assumed that all questionnaires were answered truthfully and were noise-free.

As a first step, we performed data summarization to detect the central tendencies and trends in the data. We employed histograms and scatter plots to further analyze our data. Through visual inspection, we obtained insights into the possible correlations and dispersion of the data. Also, the given answers to the survey questions were analyzed and processed to identify the possible values for each one of them.

Next, we engaged in data cleaning, which mainly focused on handling missing values. For the questions that were left blank, a "?" symbol was entered, to indicate to the data mining algorithms that this is a missing value. Data mining algorithms are designed to generalize over such missing values and to construct high quality models, given that the remaining values are sufficient (Han and Kamber, 2005). During data transformation, the answers for some questions were divided into several nominal columns to match the requirements of the data mining algorithms, resulting in a total of 136 fields. These fields included demographic details such as age and gender, place of residence, information about Internet access points, as well as information about mobile phone uses (e.g. talking or sending SMS messages) and capabilities (e.g. the ability to play games or watch videos).

Lastly, we applied data reduction through feature subset selection. Irrelevant features (or field values) should be ignored because they will have a negative influence on the data mining accuracy and may also lead to overly complex results. That is, redundant features that are not statistically significant should be screened out as they will be highly correlated with one or more of the remaining features. Reducing the number of measurements not only increases the efficiency of the learning process, enhances comprehensibility of the learned results and improves the learning performance (predictive accuracy) (Han and Kamber 2005). The Consistency Feature Subset (CFS)

technique is a widely used feature selection filtering algorithm that ranks feature subsets according to a correlation based heuristic evaluation function. This measure has been widely used in data mining exercises and has shown to produce good quality results across a number of domains (Cunningham, 2007). Our implementation of CFS used in this experiment uses a Greedy Stepwise search algorithm that begins with no features and greedily adds one feature at a time, until no possible single feature addition results in a higher evaluation.

Data mining

During the actual data mining phase, we employed two types of data mining algorithms, namely association analysis and classifications.

Association analysis algorithms find frequent re-occurring patterns in a dataset, i.e. by finding frequent items that often occur together. A typical example would be the items that customers frequently purchase together in a shopping basket, for example milk, bread and eggs. The seminal Apriori algorithm employs the concepts of minimum support and confidence to discover such frequent patterns (Agrawal and Shirtkant, 1994). The algorithm uses prior knowledge of frequent itemset properties and follows an iterative approach known as level-wise search, where *k*-itemsets are used to explore *(k+1)*-itemsets. It explores the intuitive property that all non-empty subsets of a frequent itemset must also be frequent. The algorithm creates a list of rules of the form *[PhoneTakePictures=Y, PhonePlayVideos=Y, ActMPPlayMusic=frequently, ActMPSendSMS=frequently → Internet=Y]*, which has a support higher than a threshold (say 0.5) and high confidence, where confidence refer to the probability of an item B, given item A. That is, a learner with Internet access has a phone with the capability to play pictures and videos, and the users play music and frequently send SMS messages.

Classification Analysis refers to the process of finding a model (or function) that describes and distinguishes data classes or concepts, for the purpose of being able to use the model to predict the class of objects whose class label is unknown. For example, in this trainee case study, a classifier may be used to build a model that distinguishes between male and female subjects. One of the most common ways of representing the derived model is with a decision tree. A decision tree is a flowchart-like structure, where each internal node (nonleaf node) denotes a test on an attribute, a branch represents the outcome of a test, and the leaf nodes holds a class label. The topmost node in the tree is called the root. In our experiments, the J4.8 decision tree algorithm was used to classify data. This algorithm uses a top-down recursive divide and conquer approach (Han and Kamber, 2006) combined with a post-pruning phase to avoid bushy trees. In our setting, four different sets of decision trees were built. That is, four sets of decision trees were built to classify the data based on gender, access to the Internet, rural or urban areas, and age. In these experiments, we used the standard ten-fold cross validation method, where each of the four initial data sets where randomly partitioned into ten mutually exclusive sets. In this approach, nine set of the ten sets is used for training, while one is reserved as test set. This process was repeated ten times, that is, each sample set is used ten times for testing and training (Han and Kamber, 2006). Figure 1 shows an example tree, which were built to distinguish between persons that has access to the Internet or not (indicated by the class labels Y (Yes) and N (No)). This tree shows, for instance, that trainees in the Western Cape who works at a clinic without a personal computer are more likely to have access to Internet than their counterparts in Kwazulu Natal and the Eastern Cape.

```
J48 pruned tree
------------------

ActMP-InstantMsg = never
|   Clinic-PC = N
|   |   Province = KZN: N (12.3/3.0)
|   |   Province = Eastern Cape
|   |   |   ActMP-Facebook = never: N (14.86/2.36)
|   |   |   ActMP-Facebook = sometimes: N (4.0/2.0)
|   |   |   ActMP-Facebook = frequently: Y (2.0)
|   |   Province = Western Cape: Y (7.17/1.17)
|   |   Province = Western Province: Y (1.02/0.02)
|   Clinic-PC = Y: Y (7.36/1.36)
ActMP-InstantMsg = frequently: Y (55.82/3.41)
ActMP-InstantMsg = sometimes
|   Phone-AccessWeb = N: N (4.03/1.03)
|   Phone-AccessWeb = Y: Y (26.43/3.23)
|   Phone-AccessWeb = N/S: N (1.01/0.01)


Number of Leaves  :      11

Size of the tree :      16
```

Figure 1. Example Decision Tree for Access to Internet

FINDINGS

From the training provider's point of view, the open ended question on how the trainees view the role played by mobile phones in the post-training support, is of importance. Answers to this question provide valuable information for adjustment or design of the post-training support – or for managing expectations. From an academic perspective, the inclusion of this question proves to be insightful as will be explained shortly. Note that answers to this question were categorized as Academic, Community Life, Work related, Access to Information or N/A as shown in Table 1

What role do you think mobile phones should play in the post-training support?	
Category	**Typical answers**
Academic	"Like for instance you need information on the training that you've done, you can just easily get from your mobile"
Community Life	" Contact each other"; " They should play an important role, because to be able to communicate with your family, loved ones you need a phone, because we come from different cities and towns"
Work related	"To find me other permanent job" ; "How to do my work better or maybe tips to achieve more in my work:"
Access to Information	"To give me information and keeping me posted and updated via my cellphone"

Table 13. Categories of answers to the question on the role of mobile phones in post-training support

In the data mining literature, a number of criteria have been proposed to determine whether a pattern is interesting. These criteria are: Generality, Reliability, Conciseness, Peculiarity, Diversity, Novelty, Surprisingness, Utility and Actionability (Geng and Hamilton, 2006). Since generality, reliability, conciseness, peculiarity and diversity depend only on the data patterns, these criteria are considered objective. Objective measures are based on the statistical strengths or properties of the discovered patterns. Little knowledge about the user or application is initially required, in order to assess the degree of interestingness of a pattern (Pena, Viktor and Paquet, 2009). The criteria novelty, surprisingness, utility and actionability depend on the user, and therefore are considered subjective. In this study, we considered subjective interestingness measures, since we were interested in novel, surprising and actionable findings.

Name	Formula	Description
Support	$P(AC)$	Support is a measure of significance of the rule. Represents the fraction of records that the given rule satisfies.
Confidence	$\dfrac{P(AC)}{P(A)}$	Confidence measures the reliability of the inference made by the rule. It is defined as the probability of seeing the rule's consequent under the condition that the record also contains the antecedent.
Lift	$\dfrac{P(AC)}{P(A)P(C)}$	Lift is a correlation measure that indicates how many times more often A and C occur together than expected if they were statistically independent.
Conviction	$\dfrac{P(A)P(\neg C)}{P(A\neg C)}$	Conviction is a measure of independence of A and C that is sensitive to rule direction since also uses the information of the absence of the consequent.
Leverage	$P(AC)-P(A)P(C)$	Leverage measures the difference of A and C appearing together in the dataset and what would be expected if A and C were statistically independent.`
Recall	$\dfrac{|\{relevant\}| \cap |\{retrieved\}|}{\{\{relevant\}|}$	The percentage of results that are retrieved that are correct (true positives rate).
Precision	$\dfrac{|\{relevant\}| \cap |\{retrieved\}|}{\{\{retrieved\}|}$	The percentage of results that are correct and that were, in fact retrieved.

Table 2. Measures used to find interesting and meaningful rules

The default measure for evaluating the interestingness of a rule in Apriori is confidence. Confidence is the proportion of the records covered by the antecedent that are also covered by the consequent. A problem with confidence is the fact that is sensitive to the frequency of the consequent. Consequents with higher support

produce higher confidence values even if there is no association between the items. We then also use the interestingness measures lift, conviction and leverage. As shown by Sheikh et al. (2004), a single measure should not be used to determine the interestingness of a rule. Instead, a combination of different measures has to be used in order to get the rules that are really interesting, as depicted in Table 2. We selected the association rules with a support of at least 50%, whose lift and conviction values are greater than 1 and leverage value greater than 0. We also filtered out all rules with less than 91% confidence.

The four decision trees were evaluated in terms of classification accuracy (%), mean squared error, precision and recall. Also, Received Operating Characteristic curves, which provide a visual trade-off between the true positive and false positive rates, were drawn. Our results indicate that, applying the CFS feature selection approach prior to building a decision tree improve the quality overall accuracy of our results. In particular, the decision trees to predict whether a person has the access to Internet provided usable results (76% accuracy), as depicted in the Received Operating Characteristic curve of Figure 2. Note that the straight red line is the so-called "random guessing" line and the figure thus indicates that the model is superior to random guessing. Our results also indicated that we are able to accurately predict whether a person is young or older, but that it is difficult to predict a person with a medium age. The model built to predict whether a person lived in a rural or an urban area was only 68% accurate. The decision tree to learn the gender did not yield results that are much better than random guessing (accuracy 58%).
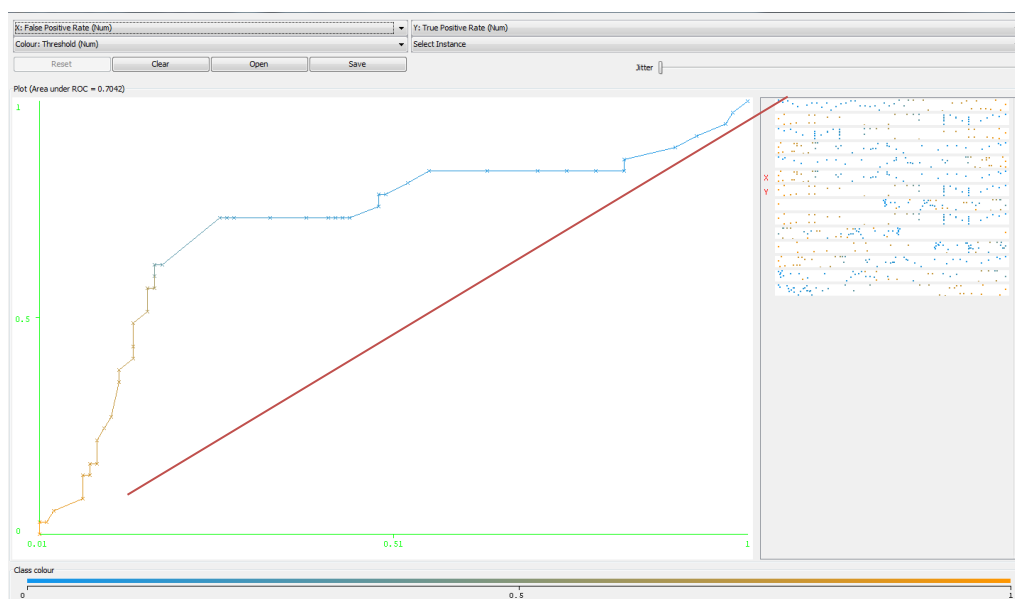
Figure 2. Received Operating Characteristic Curve for Access to Internet

In summary, the following findings from the data mining exercise which were deemed as interesting are listed below:

- All trainees own cell phones, but only 4.6% of them have laptop computers.

- Trainees use their phones mainly as a phone (make phone calls, send SMS, send please call me requests and missed calls).   Almost no one uses it to access the internet (surf the web or check email).

- Almost all people that have Internet access have it via their mobile phone, while very few have access to personal computers or Internet Cafes.

- A total of 26.5% of the trainees think mobile phones should play an academic role in the post training support; 23.5% considers it as a tool for accessing information in the post-training environment, 22.8% sees the role as that of social connector (Community Life) and 13.2% considers its role as work related. The other 14% gave other views.

- Almost all trainees living in the Eastern Cape and expect to use the mobile phone to access information (Access to Information) live in rural areas.

- Almost all the trainees that live in Eastern Cape are medium or older, but it is very rare that young people are involved in this project.

- There is no definite predictor(s) of gender and no strong association between gender and the other variables.

DISCUSSION

The findings above confirm some findings from existing research and give some pointers towards more focused future research. These are discussed below.

Gender

Castels et al (2007) report that, in general, where diffusion levels of mobile telephony is high, the gender difference in mobile technology diffusion is growing smaller. They continue by studying different world regions on this trend and discuss two studies on South Africa which contradict each other: Huyer et al (2005) in Castells et al (2007) find a large distribution gap whereas Samuel et al (2005) in Castells et al (2007) find that females are the predominant users. The findings of this paper confirm the research by Samuel et al: all trainees own cell phones and 62% of the respondents are female.

There is, however, a difference in the way mobile telephones are used by males and females. Castells et al (2007) mention one consistent gender-related finding across countries, namely that females tend to see mobile phones as a safety and security measure. Another consistent finding is that women use mobile phones to maintain social networks. We tried to determine any gendered views on the role of mobile phones in this paper. The data mining results does not show any strong association or predictors with regard to gender. However, by simply looking at the percentage of the remarks given by the females versus the males on the role of mobile phones, some differences are noted, as depicted in Table 3.

Category	Female	Male	All
Academic	26%	27%	26.5%
Community Life	26%	18%	22.8
Work related	15.2%	10%	13.2%
Access to Information	21%	27.4%	23.5%
Other	11.7%	17.6%	14%

Table 3. Frequency distribution of answers to the question on the role of mobile phones in post-training support between males and females

Although none of the differences noted above are necessarily significant, it is interesting to note the higher percentages of females viewing the role of mobile phones in the post-training support as one of social connector than males. This seems to confirm the findings noted by Castells above where women tend to use mobile phones for social networks. However, the trend reported here can only provide valuable pointers toward more focused research on gendered usage.

Mobility versus Connectivity

Castells, Fernández-Ardèvol, Qiu and Sey (2007) mention in their comprehensive overview of mobile communication and society, the difference between developed and developing countries in defining mobile phones: developed countries consider the concept of "mobile" to be the defining aspect of mobile phones – that is, it is a mean to communicate on-the-go, whereas developing countries see the immediate benefit as that of "connectivity" – having the means to communicate whether mobile or not. Although not a result from the data mining effort, the research reported here confirms this divide. Our study takes place within a developing context and only 9% of the trainees mention any aspect of the mobility of mobile phones in their answers on the question on how they perceive the role of mobile phones in the post-training support. Of that 9%, 30% respondents live in rural areas and the other 70% in urban areas.

Rural vs Urban

Both Castells et al (2007) and Donner (2008) note the absence of nuanced research on the rural-urban divide within developing countries (referring to mobile telephony). Donner (2008) asks for the integration of "the relationships between rural and urban users into a single analysis" to "reveal ways in which the mobile mediates intra-national (and international) social and economic networks". According to the data mining results of this study almost all trainees living in the Eastern Cape and who view the use of mobile phones as access to information in the post-training support (Access to Information), live in rural areas. When examining the data related to this finding the following tendency, as shown in table 4, is observed.

The stark contrast is between Eastern Cape and the other two provinces both in terms of the rural versus urban area as well as age. (This is also in line with the findings that almost all the trainees that live in Eastern Cape are medium or older). Why coming from Eastern Cape and viewing mobile phones as access to information in this project become predictors of living in rural areas, is not immediately clear. In this research, mere speculations must suffice.

The Eastern Cape is known as one of the poorest provinces of South Africa. Two former homelands (Transkei and Ciskei) are situated in this province and migration to urban centres from these impoverished rural areas still comprises the livelihood strategy for many households in those regions (Skuse and Cousins, 2007). Family members live in urban areas where jobs are more readily available and the income is shared across the extended kin-networks. This might explain the absence of young people in the rural areas. The view of the mobile phone as access to information in the first place (without mentioning the type of information – whether related to the work place or the project), might relate to a more urgent information need experienced by these trainees. Wilson (1999:252) considers information need as not a "primary need, but a secondary need that arises out of needs of a more basic kind". According to him, the basic needs can be defined as physiological, cognitive or affective. (These aspects were not explored in our research.) He further suggests that the barriers impeding the search for information will arise out of the context of either the person, the role demands of his/her work life or the environment (which may include economic, political or technological aspects). These concepts and relationships (e.g. limited access to information technology, information illiteracy and personal and regional poverty) might provide helpful to come to a better understanding of the trend that was identified. It also confirms the complexity of the rural-urban divide in viewing mobile telephony.

Province	Rural	Urban	Young age (16 – 20 years)	Medium age (21 – 25 years)	Older age (over 26 years)
Easter Cape	8	2	1	2	7
KZN	2	10	9	3	0
Western Cape	1	8	8	1	0

Table 4. Comparison of demographic distribution of number of respondents viewing the role of mobile phones as tools to access information

CONCLUSIONS

The research reported here is part of an ongoing study on "project 3535" where the Department of Health of South Africa embarked on the training of 3535 unemployed youth from all provinces as data capturers that can be employed in health facilities. The purpose of this paper is to report on findings obtained by applying data mining techniques to data obtained from one group of trainees of 136 students trained in January 2011. Most of the findings support existing research results. One interesting finding relates to trainees from Eastern Cape: those viewing mobile phones as access to information live mostly in rural areas. This is in stark contrast to the other provinces. Further research on this finding may contribute to the need for more nuanced research on the rural-urban mobile technology divide as identified by Castells et al (2007) and Donner (2008).

The findings confirm the experience of the training provider of this training, namely that most trainees, irrelevant of age, region (urban or rural), gender or rates of technology literacy are ready to embrace the mobile post-training support platform. A shortcoming of this analysis lies in the subjectivity of the interpretation of the answers on the open-ended questions in order to categorise them. An improvement in further research would be to provide trainees with fixed format questions. It follows that we will expand this work once the results of questionnaires from all participants have been collected, to see if the conclusions as reached in this paper hold and to detect actionable rules to address the rural-urban divide.

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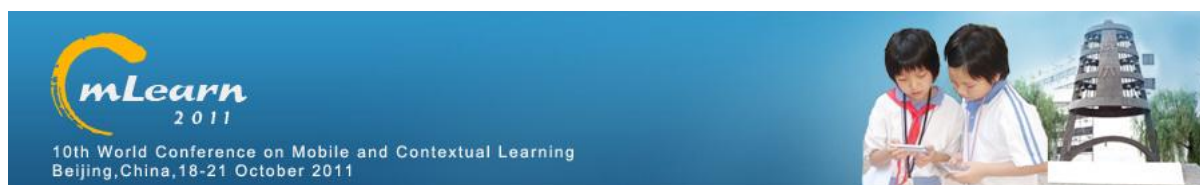
The Ethics of M-Learning: Classroom Threat or Enhanced Learner Agency?

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ABSTRACT

Ubiquitous access to mobile technologies is expanding rapidly. In a changing world, where social, work and learning activities increasingly occur 'on the go' mediated by a wide variety of mobile devices, there is a growing expectation that these tools will be utilized for teaching and learning activities in higher education. However, along with the opportunities offered by mobile learning come concerns related to issues of privacy and security within classroom situations. The authors of this paper suggest that while mobile learning does indeed come with risks, there is a need to take a proactive approach to managing the ethical issues that the use of these tools in educational settings can create. Considering mobile learning as part of a transition to a more mobile society, the authors argue that ethical issues need to be considered within this social framework and that the onus is on institutions to develop protocols and policy to enable and support responsible use of mobile devices as tools to support mobile learning. Moreover, mobile devices in education should not be seen merely as a problem to be managed, but as offering the potential to enhance the agency of all learners, including those who have been disenfranchised by traditional teaching approaches.

Author Keywords

Mobile learning, ethical issues, positive responsibility, enhanced learner agency, institutional codes of ethics

INTRODUCTION

Blended and online education is possibly the fastest growing sector within higher education (Gupta and Koo, 2010). As more universities develop their infrastructure to cope with student demand for flexible access and the incorporation of online components into the curriculum, m-learning solutions create an ease of access to curriculum and learning activities for students and staff alike. Institutions and academics have an interest in m-learning but often this is a naïve or limited view (Pachler et al., 2011), with little recognition of the transformative potential of m-learning in changing teaching practice or of its role in the transition to a more mobile society (Traxler, 2009). Flexibility in learning has been absorbed into the higher education sector discourse for some time and, along with an increasing desire for anywhere, anytime and anyhow learning (Ramaprasad, 2009), is stimulating mobile device use for teaching and learning activities (Peters, 2009).

As mobile technologies and their use are a product of and a part of social and cultural practices, the issues related to social purpose, are worth considering in considering their use for educational purposes i.e. for m-learning. Field (2005, pp. 115-6) discusses the impact of emerging technologies on social capital, the trust and reciprocal relationships between people in society and the development of communities and places in cyberspace 'where people actively construct their identities as parts of wider sets of shared relationships.' The use of m-learning approaches presents opportunities to engage with a range of knowledge sets, constructs and contexts beyond those found in many formal or desk based educational settings. This might include multimedia based representations of diverse home life and beliefs systems, or representations of knowledge as constructed by different social and cultural orientations. Through educational experiences, learners can use m-learning to make connections between learners' worlds, make unfamiliar contexts more accessible and create ways of interpreting knowledge that reflect different ways of knowing.

However, while the technology is fast becoming ubiquitous and the unique characteristics of m-learning provide a tempting solution for educational provision, moral, ethical and pedagogical thinking is struggling to keep pace.

Early adopters are paving the way for rapid up-take but, alongside the transformative possibilities (Traxler, 2009; Gordon, 2002), there are some cautions to be considered, especially as more examples of inappropriate use of mobile devices for capture of evidence in workplace settings are emerging in the popular press and elsewhere. Managing risks that can be created through the use of mobile devices such as a potential lack of privacy on some social media sites, (for example, Fitzgerald, 2011) is an emerging concern. Additionally, there is a need to consider the ways in which the use of such tools can provide opportunity for disenfranchised learners. Taking advantage of the opportunities which abound for individualising relevant, convenient learning within the safeguards for professional and ethical behaviour are concerns of this paper.

The remainder of this paper discusses mobile learning in the context of social change and suggests that ethical behaviours in relation to the use of mobile learning need to be considered from different perspectives. The paper discusses some of the ethical issues and concerns that can arise as a consequence of integrating mobile devices into educational settings. It also considers some approaches to developing an ethical framework to manage appropriate use of mobile devices to support mobile learning.

MOBILE LEARNING

We use a broad definition of mobile or m-learning based on work by prominent authors such as Pachler et al., (2011) and particularly Wallace (2009a) which goes beyond the technical to encompass pedagogical, social and cultural dimensions. This perspective considers that mobile learning draws on mobile technologies used by learners to engage with others in their lives to communicate and develop knowledge. Highlighting the unique aspects of mobile learning, Geddes (2004) suggests that mobile learning can extend opportunities for learning in ways that can enable better use of time and support greater flexibility:

It provides access to learning during previously unproductive times, it allows more flexible and immediate collaborative options, it allows controlled learning in contextual situations, and provides greater options for teachers to observe and assist in independent learning *(p.13)*.

However, a critical aspect of mobile learning is mobility and, as Miller, (2010. p. 15) points out:

Mobility is the fundamental feature of 'm-Learning'; it is what distinguishes the field as separate and unique from other similar fields. ... The 'mobile' aspect of 'anywhere, anytime' learning is what is essential and is perhaps the most important aspect of 'm-Learning'.

This concept of mobility, greatly enabled by increasingly ubiquitous access to mobile technologies is impacting broadly on all aspects of society. Further to this Traxler (2009) suggests that there is a need to consider m-learning as part of a larger societal transition to a more mobile society, with mobile technologies mediating many aspects of our daily work, learning and social lives. From this perspective the authors consider ethical behaviour in relation to mobile learning to be an essential aspect of developing protocols and procedures for using mobile devices in a mobile society where such tools are the norm. This view is supported by Wishart and Green (2010), who identify ethical considerations as one of the major concerns in relation to mobile learning in higher education and suggest:

The need for the development by students and staff of agreed practice, establishing how mobile devices are to be used responsibly in institutions before inconsiderate use or ignorance of their potential to enhance learning results in banning a valuable learning tool (p.1).

In many applications of mobile learning in higher education to date, ethical considerations have not been a particular concern. We need: 1. Methods for academics and learners to easily follow and replicate, and 2. Leadership at the institutional level to improve understanding of the benefits of m-learning and its implementation without ethical problems arising.

NEW ETHICAL SITUATIONS WITH MOBILE TECHNOLOGY

New technologies bring with them new ethical situations, and mobile technology is no exception. Ling and Donner (2009) note that the explosion of mobile devices in recent years has created a clash with accepted behavioural norms. For example, answering a mobile phone call at the dinner table challenges understandings of etiquette which privileges people physically co-present over those geographically removed. Moreover, a US study found that many people are bothered by intrusive, private calls in public places and on public transport, while often making such calls themselves (Barron, 2008). One of the problems is the lag between the rapid development of the technology and the more gradual evolution of rules governing its use (Castells et al., 2007).

Likewise, with the use of mobile technology in the educational setting, there have been many concerns voiced about inappropriate use and the lack of rules to guide teachers and educational institutions. These unethical be create a fear of the new technology and encourage teachers and institutions to implement wholesale bans of mobile devices in the classroom. Some examples of unethical use will illustrate the point.

In an early study, Ling (2000) noted the well established use of text messaging by Norwegian students at school, and quoted examples of SMS being used as a replacement for passing notes in class. Campbell (2006) comments that many US students divert themselves from their studies by playing video games in class on their mobiles or laptops. Furthermore, he surveyed students and academics and found that phones ringing in the classroom severely annoyed and distracted both groups, although younger people were more tolerant of this than older people.   Burns and Lohenry (2010), in a survey of postgraduate health science students and their teachers, found that more than 40% of students used their mobile phones in class to either send text messages or check incoming phone messages, while over 70% had their phones ring during class. Like Campbell's study, most students and staff found mobile phones distracting. Even vibrating phones and backlit screens were annoying to some survey respondents.

Cyber bullying is of growing concern in schools and exacerbated by mobile technology. Ling and Donner (2009) explain how bullies can hide behind the anonymity of mobile phones and send offensive messages without the supervision normally provided by teachers or parents when students are using computers. They can reach their victims at any time and in any place.

One of the greatest ethical concerns with mobile devices in the educational context has been their use in cheating. Some authors have gone so far as to claim an "epidemic of cheating", facilitated by computer, online and mobile technologies (Heyman et al, 2005). SMS has been used to ask peers questions in the middle of exams, and mobile phone memory can store "cheat sheets" to be consulted during exams (Ling, 2000). Taking photos of exam papers for distribution to friends also occurs (Campbell, 2006). Ling and Donner (2009) quote a famous case where a University of Maryland professor posted bogus answers to an exam while it was in progress and caught a dozen students who had received the false answers via SMS from friends who were not sitting the exam at the time.

Ethical Issues with M-Learning
Equipping students with mobile technology or encouraging them to use their own devices to undertake m-learning activities obviously opens the way to some of the ethical abuses outlined above. For example, if students have their phones switched on for learning, some may be tempted to start texting friends or playing mobile games.

Furthermore, because m-learning lends itself readily to learning outside the classroom, many new ethical situations are likely to arise. Gayeski (2002) points to the potential loss of privacy when mobile devices are equipped with GPS capability and the learner's location can be tracked. She also highlights the possibility of data interception when learners transmit information via wireless networks. Londsdale et al. (2003) note that the gathering of contextual data in fieldwork, workplace training and informal learning results in data which is often personal and private to the learners. This gives rise to issues of informed consent and potential misuse of stored data by third parties. Not only is data captured which is private to the learners, but there is a very real possibility of photos, videos or sound recordings being taken of people in the field without their permission and then being used in an unauthorized manner, for example being uploaded to social media sites such as YouTube or Flickr. The area of clinical and practice education, in particular, raises many issues in relation to the use of mobile learning which, while offering many learning benefits, including opportunities for reflective practice and just-in-time learning (Andrews et al., 2011), also creates considerable challenges in preserving individual privacy and ensuring any material is appropriately managed from a learning perspective. These concerns are often associated with the use of images:

There are particular concerns about how images are used, the ease of their capture and uploading to an online store and their usefulness in supporting learning and revision visually has meant that learner captured multimedia is part and parcel of nearly all the scenarios envisioned (Wishart and Green, 2010, p. 27).

On a different note, Engel and Green (2011) point to the ethical issue of accessibility when m-learning is introduced. If students lack a mobile device or have a disability which makes it difficult for them to use one, the educational institution must provide devices to these students, or put in place protocols to allow them to complete their tasks successfully without them.

Why Ethical Issues Arise in M-Learning
Campbell (2006), looking at why mobile phones ringing in the classroom are so frowned upon by both students and their teachers, who might well tolerate their use in other public spaces, suggested that the classroom is very strongly governed by social norms. This is the case because it represents a public forum with a collective focus, and the focus is an important one – learning. In addition, he notes the lack of competing background noises, which make a ringtone in class much more distracting than it might on a bus or in a restaurant.

Ling (2000) sees the use of SMS to pass messages in class and cheat at exams as putting in question the whole concept of the educational institution as a place of control. Students engaged in cheating using mobile devices are subverting their teachers' role as judges of whether students have attained sufficient knowledge against some abstract standard determined by the teacher or other figure of authority (criterion-based assessment), or have

succeeded in comparison with their peers (norm referencing). In addition, one can note the lack of control over student behaviour that inevitably occurs if the teacher is absent, for example, where students conduct unsupervised m-learning projects by themselves in the field or workplace. Even when accompanied by the teacher, fieldwork and workplace training inevitably result in many more potentially uncontrolled and unforeseen ethical situations. As a facilitator of learning "on the move", mobile technology can be seen as contributing to more ethical situations once it is introduced into education. There is a marked disparity between students' expectations from their use of mobile technologies in their private lives and academic expectations based on the teacher-centred paradigm.

Convergence is another contributing factor in the potential increase of ethical issues related to the use of m-learning. Now that mobile devices are increasingly equipped with multiple functions (camera, voice recorder, videocam, Internet, etc.) students can capture data about people without their permission, or take embarrassing pictures, or violate intellectual property, even without being aware that they are doing so.

Building on the work of Manner (1996) and Johnson (1997) on computer and online ethics, one can propose the notion that mobile technology has certain unique characteristics which contribute to ethical issues which are "new species of generic moral problems" (Johnson, 1997, p. 61). For example, infringements of privacy are not novel but m-learning in the field and workplace allows threats to privacy of a different nature and on a scale different than seen before when students were equipped solely with a clipboard and pen and paper.

MANAGING M-LEARNING FOR ETHICAL BEHAVIOUR

Despite the concerns about unethical behaviour, there have been few attempts to develop ethical frameworks and these are seldom comprehensive. In the context of informal and workplace learning, Lonsdale et al. (2003) note that three issues need to be covered:

Informed learner consent

Learner control over any data students collect

Maintenance of security of the gathered data.

However, they do not provide any concrete guidelines on how these matters should be enforced.

Burns and Lohenry (2010) suggest a number of practical measures to improve the use of mobiles in the classroom:

Firstly, develop a mobile phone policy

Acquaint the students with this policy and clarify any issues

Model mobile phone classroom etiquette through good teacher behaviour

Finally, reinforce appropriate behaviour in the printed syllabus and the program policy manual.

Garrett (2010) proposes a two-tier framework consisting of an overarching institutional policy, which at the same time allows some flexibility for individual academics to adopt controlled uses of m-learning if they wish. He notes that institutional policy must:

Pay due regard to legal aspects

Provide for sound pedagogy

Prevent disruption of learning

Prohibit cheating

Provide security for students and teachers by preventing dissemination of recordings of class activities without consent.

Classroom policies that he recommends for academics cover much the same ground but also include the need to be inclusive of all students and adapt to students' learning styles and classroom culture. Despite these additions, the constant thread running through Garrett's paper is one of recognition of risks, and caution in adopting mobile technology in learning.

Technical solutions have begun to be considered seriously (Turilli, 2007; An et al., 2009; Sadeh et al., 2009; Lehikoinen et al., 2008). That said, it is certain that technical solutions are only part of a complex problem, which ultimately relies on individuals' personal attitudes and behaviour. Searching for exemplars of guidelines and institutional policies shows that some institutions are beginning to adapt existing ethical guidelines to the use of mobile devices and mobile learning, at least in medical schools. For example, the University of Texas Medical Branch has an office of institutional compliance grappling with these issues and providing guidance to staff and students about professional behaviour in clinical settings when adopting devices from the digital world (http://www.utmb.edu/compliance/hipaa/dos&dontslist.pdf) .

In contrast to the top-down approaches above, Engel and Green (2011) advocate a more democratic model in which students set their *own* rules. They note the great advantage of this in their pilot was that the students "took ownership of the rules because they created them" (Engel and Green, 2011, p. 40). The students in their mathematics course set both guidelines to follow for ethical mobile phone use in the class and also consequences if students failed to comply. Their rules stated that:

Students should only send text messages in class which relate to learning activities

Text messages should be "respectful and relevant"

Mobile phones should only be brought out when required for class work (Engel and Green, 2011, p. 40).

The penalties for infringement devised by the students were confiscation of the mobile phone and notification of the student's parents.

In addition to these self-imposed classroom rules, Engel and Green, like Garret earlier, note the need for an institutional policy. Both classroom and institutional policies need to cover the "when, where, and how" of mobile device use (Engel and Garrett, 2011, p. 45). They also point to the importance of awareness raising: teachers must be conscious of potential issues prior to m-learning being introduced, and students must be educated about issues such as privacy and cyber bullying.

Much more work like this needs to be done in all disciplines. It will not only lead to an avoidance of ethical problems in m-learning but also foster a professional ethical standard of behaviour in our students preparing for the workplace (Burns and Lohenry, 2010).

ENHANCING LEARNER AGENCY USING MOBILE LEARNING

However, m-learning should not just be seen as a problem. It has huge positive ethical ramifications through its affordances for interactivity and multimedia note-taking, which can create the basis for shared learning conversations. It has the potential to subvert teacher dominance in the classroom and the didactic approaches to education which arose during the industrial era, such as the transmission model. To replace these, it can substitute a more learner-centred paradigm, where students are in control of their own learning:

Mobile devices create the possibility for active, student-centred learning in which students create their own knowledge, collaborate with their peers and move into the world outside the university to learn in context (Dyson, Litchfield and Raban, 2010).

Mobile learning has been utilised to engage disenfranchised learners and explore the different ways learners use mobile learning to communicate in ways that are meaningful to them. The uses of technology have developed with the technological advances and, as Kress and Pachler (2007) note, includes the incorporation of a range of devices into many peoples' social and cultural practices. The advantage of mobile learning is that it starts from the learners' personal use, their construction of purpose and connects to their agency as a learner. This is a source for connecting to learning and for learning institutions to connect to learners. As Snyder and Prinsloo (2007) note, the relationships between digital literacy practices in different contexts are complex and differentiated by people's connections to local and global communities. Vosloo, Wilton and Deumert (2009) describe the different usage of mobile technologies by young learners without access to computers outside school, to read and create m-novels, and suggest that their use of such tools is determined by the learners' social context. As they note (2009, p. 208):

…the mere presence of a technology such as a mobile phone or mobile Internet will not shift cultural practices in marginal contexts and make them resemble more highly valued activities in better resourced contexts elsewhere.

The integration of m-learning has the potential for learners, particularly disenfranchised learners, to accurately represent and share their own worlds while also exploring others in safe environments. A range of people, knowledge and contexts that are meaningful for empowering learners identity can be shared and explored to support individuals' learning. Learners are able to organise and create information in ways that are mediated by a range of digital tools. Mobile technologies are accessible to a wide range of people who do not have ready access to other forms of e-learning such as desktop computers and high speed internet (Wallace, 2009a).

For disenfranchised learners, many forms of e-learning are just as alien as the educational systems they have already rejected. M-learning utilizes technologies, activities and social systems that are already integrated into many people's lives, including those who have had limited access to or rejected formal education systems (Wallace, 2009a).

In Europe, interesting m-learning and training projects have been implemented in Romany communities, for refugees and recent immigrants, adult literacy and numeracy learners, and hard-to-reach workplace learners (Stead, 2005). ComeIn is a European project aimed at providing access to learning activities via mobile phones for

young, marginalized people who cannot be reached by conventional education (Marschalek et al., 2009). In Australia, m-learning has been successfully demonstrated with young people with poor employment histories, records of incarceration or other backgrounds of disadvantage (Ragus et al., 2005).

Indigenous people, too, have adopted mobile phones and MP3 players at a far greater rate than fixed-line phones or personal computers. As a result, the advantages of m-learning for this group are now starting to be recognized. In the context of Aboriginal Australia, mobile phone calls and text messages have effectively recruited and organized students for courses in financial literacy; the multimedia capabilities of mobile devices have been used to collect evidence of prior learning and current competence and build m-portfolios for adult learners; and children's mathematics has been improved via mobile phone applications (AED, 2007; Sinanan, 2008; Wallace, 2009b). In other parts of the world, podcasting is delivering courses in Maori language, while mobile devices for literacy learning have been tested with Native American children in Latin America (Kim, 2009; Switalla, n.d.).

The potential of m-learning is great not only in developed countries but also in the developing world, where mobile phones have achieved a level of acceptance never realised by other ICTs. South Africa has been one of the most active developing countries with regards to m-learning, using it, amongst other things, to deliver literacy programs and support student learning with SMS (Ng'ambi, 2005; Vosloo et al., 2009).

By promoting the transformation of traditional education to a student-centred paradigm and one which is inclusive of all learners, the ethics of m-learning can be said to move from a negative approach, in which blame and punishment are apportioned to offenders, to a positive approach. As professionals, m-learning practitioners need to adopt an ethical approach based on "positive responsibility", that is one in which the potential of m-learning is used to maximise the positive effects of mobile technology in education and training, rather than merely avoiding harm (Gotterbarn, 2001).

CONCLUSIONS

In this paper we have discussed the advantages of m-learning for a range of learners and learning contexts as well as highlighted some of the ethical issues the implementation of m-learning can create. The authors propose that the development of an ethical framework is a necessary step to more effective management of m-learning. Integrating m-learning into teaching and learning practices as a norm in which established protocols and behaviours are understood and adhered to is seen as vastly preferential to the banning of such devices as recently proposed by Huss (2009).

In this paper we have shown that an ethical framework of m-learning must have two elements:

Control – how we manage learners behaving badly and educate them about responsible behaviour with their mobile devices. This importantly includes the development of protocols for academics and institutions to follow.

How we enhance an ethical approach to learning by promoting better learning for all students and also include those currently disenfranchised by the present education system.

In order to more effectively manage the ongoing adoption of mobile learning, there is a need to develop a model of m-learning ethics which takes a wider responsibility for education in the whole society. This is generally lacking in the existing m-learning ethics literature.

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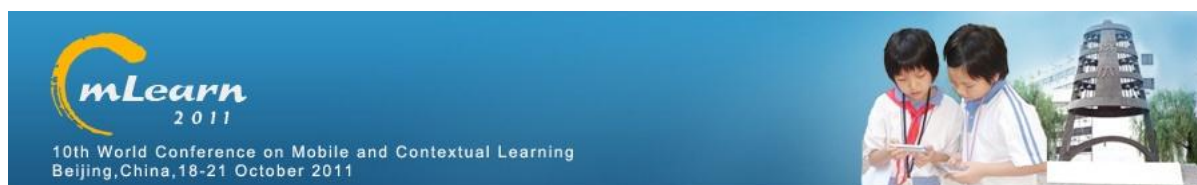
Using Technology to Address the Methodological Limitations of Case Studies

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ABSTRACT

In educational settings, the case study methodology has been used with the aim of involving students, from a learning perspective, in situations similar to those that occur in reality. Discussing a case allows students to work in collaborative groups sharing the same goal and to access knowledge from a constructivist perspective, joining both theory and practice. Although the use of case study methodology has made a relevant contribution to the study of complex problems in the classroom, the literature suggests that several critical issues make collaborative work difficult, diminishing the capacity of teachers and students to make the best use of the advantages provided by this methodology. This study suggests the use of technology as tool to address these critical issues, describing the necessary requirements and components of a prototype application running on wirelessly interconnected tablet PCs. A preliminary test of the prototype was conducted to analyze its functioning and use, its support for collaborative work and its effects on learning. Preliminary test results suggest that the prototype addresses several limitations of the case study methodology, thus supporting collaborative work.

AUTHOR KEYWORDS

Case study methodology, Information and Communication Technologies (ITCs), collaborative work, learning.

INTRODUCTION

The case study methodology was first introduced in the Harvard Business School in 1919, and its validity has since been confirmed worldwide (Bo et al. 2008). The popularity of this methodology is attributed to the approximation that the cases allow to the real world (Bruner 1986; Herreid 1994; Lundeberg et al. 1999; Rippin et al. 2002; Dori et al. 2003; Bo et al. 2008); students can solve the problems arising in reality in a collaborative way, learning by doing, teaching others and applying theory to practice (Erskine et al. 1998).

The treatment of problems drawn from real situations has favored the effective use of case studies in business (Barnes et al. 1994; Mehta et al. 2007), law, medicine and education curricula (Fraser 1931; Sperle 1933). Nevertheless, when implementing this methodology, several critical issues may arise, limiting the learning advantages provided by the case study. These issues are related to the development of collaborative work in the classroom (Bonwell et al. 1991; Herreid 1994; Bruner 2003; Tomey 2003; Yadav et al. 2007), the time required to solve the case collaboratively (Bonwell et al. 1991; Herreid 1994; Bruner 2003; Delpier 2006; Yadav et al. 2007; Johnson et al. 2008), the reluctance of some students to participate (Bruner 2003; Tomey 2003; Yadav et al. 2007), sensations of ambiguity experienced by students when developing a case study (Rippin et al. 2002), difficulties for the teacher in adapting to the new role of facilitator (Tomey 2003) and a lack of objectivity in evaluating student performance (Yadav et al. 2007).

This study proposes the design of a prototype software application, executed on a wirelessly interconnected tablet PC, to support the work of a teacher using the case study methodology by addressing these critical issues. To achieve this, three components, Online Assessment, Questionnaires and Collaborative Answer, were designed with the aim of supporting the development of the required group work for the completion of a case study. The prototype was implemented and tested using a sample of 34 undergraduate students from the Universidad de Chile to analyze its performance from a technical point of view and evaluate how this software affects the students' collaborative work while they develop a case. The results of this test suggest that the prototype components are easy for students to use, allowing the development of a case study by means of collaborative work; additionally, it was observed that these components promote participation and help to reduce ambiguity among students, improve formal and informal feedback from the teacher to the student and also provide the teacher with more information, allowing for more objective student evaluations.

CASE STUDY

Case studies include explanations of a partial studies of situations in real contexts that present real problems. The development of a case requires interactive answers from students (Cooper 1995; Taylor et al. 2003), who must analyze genuine contexts and solve problems related to a discipline (Herreid 1994; Lundeberg et al. 1999; Dori et al. 2003); the students extract the essential information, recognize the complexity and ambiguity of the practical world (Rippin et al. 2002), constantly participate (Bo et al. 2008) and develop higher-order cognitive skills (Handelsman et al. 2004; Johnson et al. 2008). Students thus feel more committed to the task and share their individual competencies (Winter et al. 2005) through social interaction promoted by collaborative work they develop while solving the problem(s) presented by the case.

Several authors have studied the advantages of applying the case study in the classroom and in different fields of education. The issues that benefit the learning process are: a) better class discussions, participation and communication (Bruner 2003; Tomey 2003; Gallucci 2006; Yadav et al. 2007); b) the application of theoretical knowledge to classroom work (Handelsman et al. 2004); c) improved retention (Yadav et al. 2007); d) better conceptual and deeper understanding (McEntee 1999; Handelsman et al. 2004; Lundeberg et al. 2006; Yadav et al. 2007); e) greater classroom motivation (Bruner 2003; Handelsman et al. 2004; Gallucci 2006; Lundeberg et al. 2006; Sanderson 2006; Yadav et al. 2007); f) the development of higher-order skills (Handelsman et al. 2004; Sanderson 2006; Yadav et al. 2007; Johnson et al. 2008); g) better problem-solving ability (McEntee 1999; Handelsman et al. 2004; Ouyang 2004; Sanderson 2006; Yadav et al. 2007); h) cooperation and competition (Handelsman et al. 2004; Yadav et al. 2007); i) multiple perspectives (Ouyang 2004; Yadav et al. 2007); j) making action plans (Ouyang 2004); and k) enabling the transfer of ideas to new contexts (Lundeberg et al. 2006).
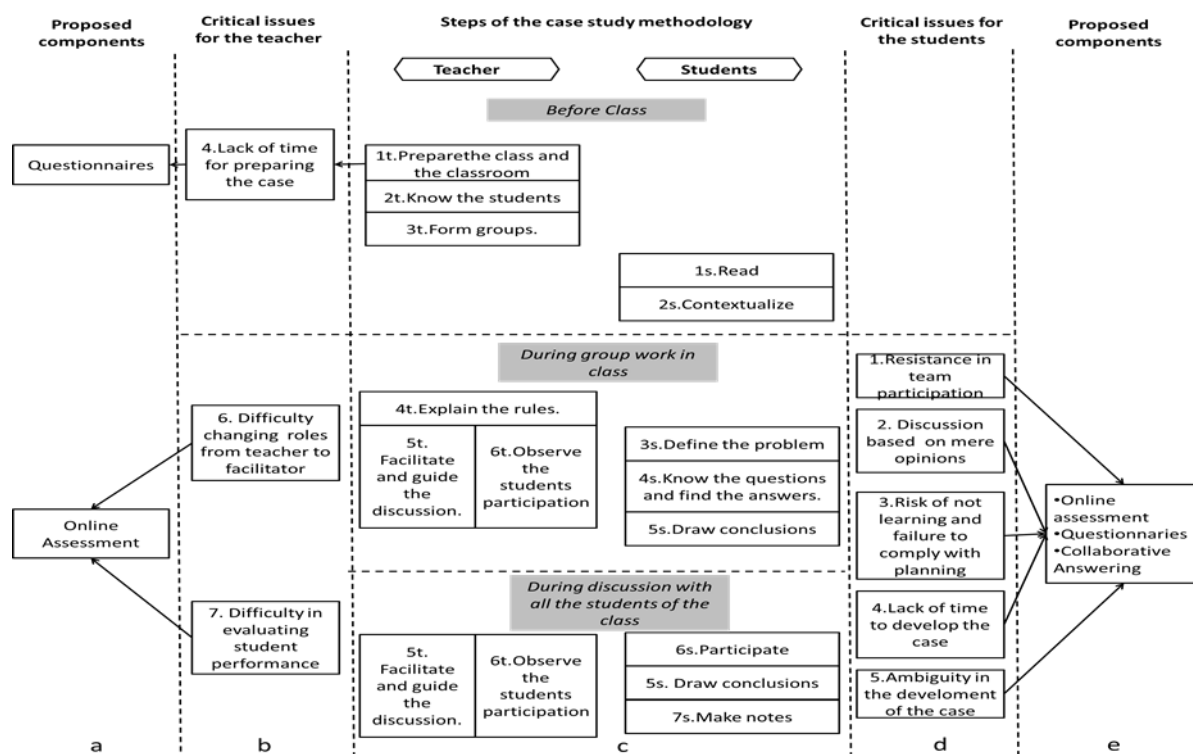
Figure. 1. Steps of the case study methodology (column c), critical issues (columns b and d) and components of the prototype proposed (columns a and e).

METHODOLOGY

In the following, we present the steps executed by both the teacher (designated by a number plus the letter "t", indicating teacher) and students (designated by a number plus the letter "s", indicating student) during the development of the case study methodology. These steps are performed in three stages: in the first stage, students prepare for a discussion of the case before the class, in the second stage, students discuss the case in groups, and in the third stage, the students discuss the proposed solution jointly with all the members of the class.

The teacher is responsible for the development of the following steps: 1t) Prepare the class and the classroom: This step consists of carefully selecting the case study according to the issues raised in the curriculum and the students ́characteristics (Charan 1976; Bruner 2003). The cases should be to the teacher ́s liking (Bruner 2003), and the teacher should internalize, prepare and understand them completely so as to be able to guide and take control of the discussion in the classroom; in this sense, the teacher should raise questions for the students and

project possible answers and so train them for discussion (Charan 1976). 2t) Know the students: The teacher must know the students` age, interests, academic experiences and expectations to be able to motivate them to participate during the development of cases (Charan 1976; Bruner 2003). 3t) Form groups: The teacher needs to organize the groups of students that are going to work in the class (Charan 1976; Bruner 2003). 4t) Explain the rules: It is extremely important that the teacher explains to the students the conditions for the development of a case study at the beginning. Such conditions refer to the student preparations required before the class, rewards for student actions and recommendations for successful solution of the cases, such as taking notes (Charan 1976; Bruner 2003). 5t) Facilitate and guide the discussion: While the group of students develops the case, the teacher is present to guide the discussion and promote a favorable environment for discussion (Bruner 2003). 6t) Observe student participation: The teacher must take note of the students' participation in sessions for further evaluation (Charan 1976). Steps 1t, 2t and 3t are conducted prior to classes; step 4t is performed in the class before starting the development of the case study. Steps 5t and 6t are performed simultaneously in the work within the groups and during the discussion with all the members of the class conjointly.

The activities described below are executed by the students and comprise the collaborative work produced in the completion of a case study due to the presence of factors that lead to an effective collaboration according to Dillenbourg (1999). These factors involve individual responsibility, as shown in steps 1 s, 2 s and 7 s; additionally, they involve mutual support among classmates, positive interdependence, social interaction and the formation of small groups, which is seen in steps 3 s, 4 s, 5 s and 6 s.

1s) Read: Students should read the case quickly to get an idea of what it is about (Bruner 2003). 2 s) Contextualize: In this stage, students read the case thoroughly, making links between details and organizing the information in some useful fashion, during which it is advisable to ask questions, make and examine assumptions and take a decision-making role (Anwar 2001; Bruner 2003; Taylor et al. 2003; Heitzmann 2008). 3 s) Define the problem: This step consists of a discussion among the individuals of the group to identify the problem(s) in the case and the various perspectives involved (Anwar 2001; Bruner 2003; Taylor et al. 2003; Heitzmann 2008). 4 s) Know the questions and find the answers: Students address the questions in groups (Anwar 2001), developing an action plan (Taylor et al. 2003) in which they propose possible solutions to the stated problems to be supported and defended during the discussion (Heitzmann 2008). 5 s) Draw conclusions: This involves evaluating the progress of the discussion, deciding what revisions should be made to the initial action plan and examining any new problems that may have appeared (Taylor et al. 2003).

6s) Participate: According to the action plan and the solutions found, students choose one position to argue and analyze during discussion with the whole group (Bruner 2003). 7 s) Make notes: It is recommended that once the discussion has ended, students make notes on the corrections and conclusions they have found (Bruner 2003).

From these activities, students perform steps 1 s and 2 s in the stage before the class; steps 3 s and 4 s are developed in the stage of discussion within the groups, steps 6 s and 7 s are performed in the discussion stage with all the members of the class and step 5 s is performed in the discussion within the groups and also in the discussion with all the members of the class. The stages of discussion within the groups and with all the members of the class each require collaborative work by the students, necessitating the processes of interaction, coordination, communication and negotiation. Column c of figure 1 outlines the steps that both actors must develop, the sequence in which they are developed and the corresponding stage for each step.

Critical Issues	Requirements	Proposed Components
1. Some students resist team participation (Bruner 2003; Tomey 2003; Yadav et al. 2007), as they think they lose time and are reluctant to express their opinions.	• Feedback motivating the students to interact. • Tools that facilitate communication and negotiation among students to reach consensus through the participation of all the members of a group and that the final answer is not imposed by some member (s).	Online Assessment, Collaborative Answering
2. In the debate, the social interaction can lead students to concentrate on mere opinions, moving them away from the evidence and the case analysis (Herreid 1994).	• Feedback, communication and interaction to redirect the discussion towards arguments based on science, evidence and analysis of the situation presented.	Questionnaires, Online Assessment
3. Risk that students do not participate nor learn the content desired or that they may feel they do not have the necessary skills to solve the problems of the case (Bonwell et al. 1991).	• Feedback for coordination among students to motivate them in the development of the learning process. • A tool that facilitates defining and following planned activities.	Questionnaires, Online Assessment
4. The increased time requirements for both the development and utilization of a case study (Bonwell et al. 1991; Herreid 1994; Bruner 2003; Delpier 2006; Yadav et al. 2007; Johnson et al. 2008).	• Feedback to keep discussions under control without losing the focus and so best utilize the time employed. • A tool to facilitate the reuse of case study material.	Questionnaires, Collaborative Answering, Online Assessment
5. Students want a tangible product from the sessions; on finishing the task, they prefer arriving at a specific product rather than an	• Feedback to inform the students about their performance in the development of the case study.	Online Assessment,

abstract solution (Rippin et al. 2002).		Questionnaires
6. Difficulty changing roles from teacher to facilitator (Tomey 2003) to encourage feedback, participation, maintain a balance between flexibility and control, and motivate students to reach an answer formulated by themselves (Jipping et al. 2001).	• Feedback allowing the teacher to lead the discussion while the students remain the main focus in the process of discussing the case.	Online Assessment
7. Difficulty in evaluating student performance, as they must be assessed for multiple aspects such as individual preparation, performance and group performance (Yadav et al. 2007).	• A tool that enables the teacher to observe the students' performance and evaluate their work.	Online Assessment

Table 1. Critical issues of the case study methodology with requirements identified and components proposed for the treatment of each issue.

CRITICAL ISSUES LIMITING THE CASE STUDY METHODOLOGY

Despite the benefits that the case study methodology presents, the literature also suggests the presence of several difficulties that may arise during the completion of a case study; we call these critical issues associated with the steps of the methodology, as shown in columns b and d of figure 1. These issues are explained in the first column of table 1 and are mostly associated with collaborative work (critical issues 1, 2, 3 and 4). Additionally, it was found that students may have a sense of ambiguity during the application of the methodology (critical issue 5), whereas the teacher may have problems in changing roles from lecturer to facilitator (Bo et al. 2008) (critical issue 6) and in evaluating the students objectively (critical issue 7).

In the following, we discuss the solutions suggested by the same authors who identified the critical issues, complemented by the contribution of feedback as a relevant element to support improvements related to these issues. Through formal feedback (comments based on the students' finished tasks) and informal feedback (comments based on what the teacher observes while the students perform their tasks), teachers can help students who experience difficulties by motivating them in their work (Erskine, 1998), making a tool that facilitates this process useful for diminishing the occurrence of critical issues, as shown in table 1. It is possible to reduce student resistance to participation (critical issue 1) by generating an interactive environment in which students receive feedback on their performance; this encourages students to feel motivated to participate and exchange ideas with the teacher and their classmates (Siau et al. 2006).

The fact that students may develop a discussion based on mere opinions (critical issue 2) must be addressed by the teacher, who must be alert to keep the discussion focused on science, evidence and analysis through feedback (Herreid 1994). With regard to the risk that students will not use or develop higher-order thinking skills nor learn the desired contents (critical issue 3), feedback aids in the transfer of knowledge and improves the learning process, thus influencing student learning outcomes such as attitude and achievement (Siau et al. 2006). Additionally, planning activities helps to maintain a structured order and avoid neglecting any learning objectives (Bonwell et al. 1991).

One way to address the lack of time needed to develop and use a case study (critical issue 4) is by reusing case study material (Johnson et al. 2008). Moreover, feedback is also an important element in addressing this issue, as the constant orientation of the teacher allows the students to focus on the problem more accurately, enabling them to reduce discussion time without neglecting the relevant issues to be discussed. Additionally, we observe that critical issues 1, 2, 3 and 4 are related to the stage of collaborative work, suggesting an additional solution to those mentioned above, which consists of promoting the four components of collaborative work: interaction, coordination, communication and negotiation (Kreijns et al. 2002) to treat these critical issues.

The inclination of students towards the interchange of ideas through a process of feedback (Nicol et al. 2006) helps students to feel more confident and have a more precise perception about their own performance; this contributes to diminishing their sensation of ambiguity when completing a case study (critical issue 5), for example, when they do not know whether they did the right thing. With regard to changing roles from teacher to facilitator (critical issue 6), the teacher must exchange traditional methodologies for methodologies that demand the active participation by students, focusing more on their interaction than following the instructions given by the teacher. This change necessitates that teachers place the students at the center of the learning process, encouraging their participation through constant feedback (Bo et al. 2008). In the objective evaluation of performance (critical issue 7), feedback is a tool that helps the teacher to know accurately the performance of his students and can, through a tool that allows taking note of what is observed, take into account more details of such performance.

PROPOSED COMPONENTS TO ADDRESS THE CRITICAL ISSUES

The use of Information and Communication Technologies (ICTs) in the classroom has changed teaching methods, improved teaching techniques and presented new methods that combine successful techniques with new and unique ideas (Jipping et al. 2001). These types of technologies can be used in traditional teaching methods, providing new platforms to strengthen these methods (Jipping et al. 2001). Additionally, ICTs can also facilitate the collaborative process in the classroom (Siau et al. 2006) and support the development of feedback, a major

element in addressing the critical issues that may occur in the development of the case study methodology, as explained in the previous section.

As shown in columns b and d of figure 1, the critical issues in case study methodology are present during the discussion within the groups and the discussion with all the students of the class, where collaborative work is the main feature. To address these issues, it may be beneficial to use technology to intervene in the steps comprising these stages, as shown in column c of figure 1, by facilitating collaborative work and by supporting the tasks of the teacher in providing effective feedback to students and performing the role of facilitator to cultivate the appropriate environment for students to discover answers (Erskine et al. 1998). As shown in table 1, we established the requirements based on the recommendations for improvements with respect to the critical issues that can arise in case study methodology. After identifying these requirements, we then implemented solutions through ICTs by designing components for a prototype application to be used in the classroom to achieve the intended learning and minimize the impacts of critical issues that may occur during the development of this methodology.

Three main components were defined as part of the prototype application for tablet PC: online assessment, questionnaires and collaborative answering. It is expected that these components will intervene positively in the critical issues of case methodology, as shown in columns a and e of figure 1, and facilitate the development of collaborative work by supporting interaction, coordination, communication and negotiation among the students.

For the design of technologies that support collaborative work in the classroom, Dillenbourg et al., (2010) suggests a set of factors that these technologies must consider to be functional in a formal learning environment. These factors relate pedagogical and technological design to the dynamics of the classroom (Dillenbourg, et al. 2010) and are classified into 9 categories: 1) Teacher Centrism, involving the teacher as an actor guiding the learning process; 2) Cross-Platform Integration, enabling technology to be mixed with diverse learning activities; 3) Sequentiality, ensuring continuity in the use of technology by students throughout different stages and promoting favorable reactions among them; 4) Time Management, to provide the teacher with the necessary flexibility when assigning time according to the relevance of the topics to be discussed; 5) Physicality, used in the classroom to enable the teacher to stay informed about what is happening there; 6) Species, ensuring that any person should be able to use the technology; 7) Selection, to deal with objectives inserted in curricula and to develop activities that prepare students for their postassessment; 8) Minimalism, providing an environment with the functionalities necessary for the scenarios to be addressed; and 9) Sustainability, ensuring its use in the future.

The three components of the prototype application incorporate the presence of many of the factors suggested by Dillenbourg et al. (2010). "Teacher centrism" is reflected in the fact that the teacher is an essential actor and can permanently intervene in the learning process. The objective of the prototype is to support the development of the case study methodology, enabling its accomplishment with "Cross-Platform Integration" factors to be used with the objectives and activities contained in the curriculum and with several topics to be developed through completion of the case study. "Time management" assists the teacher in planning the subjects to be addressed and the time and effort to be invested. "Physicality" is embodied as the completion of case studies is conducted in the classroom in the presence of the teacher. "Selection" involves the teacher selecting the topics and modifying them so that the completion of the case study using the proposed application provides the students with the tools required to meet their assessment goals. Finally, it is expected that after a test of the functioning of the prototype application is performed, it can be modified to ensure its flexibility and facility of use for both teachers and students, thus fulfilling the factors "Species" and "Minimalism" as defined by Dillenbourg et al. (2010).

The following describes the characteristics of the 3 components of the prototype. In the column "proposed components" of table 1, we list the components satisfying the stated requirements and having the desired impact on each of the critical issues.

Online assessment: This component is useful for both the student and the teacher. For the student, its function is to provide performance feedback; it consists of alerts on the screen of the tablet PC that appear in real time on the questionnaires answered by the students. Figure 2a shows an outgoing alert from the teacher, informing the student that his answer is correct. When the system provides feedback automatically, an emerging symbol is displayed, such as those shown in figure 2c.

With this tool, where the performance of students is always visible and available, it will be possible for students to stay informed, as the system automatically displays whether their answers are right or wrong when responding in the case studies. It is expected that providing students with this information about their performance can contribute to 1) motivating them to interact in discussions and negotiate with their classmates; 2) developing higher-order thinking skills such as communication and argumentation; 3) discovering the central topics of the cases, focusing communication and negotiation on the relevant elements and the evidence provided by the case and avoiding losing the focus of the discussion and thus becoming more efficient with the time employed to

complete the case; and 4) reducing the ambiguity faced by students about what is correct, as they recognize, thanks to feedback, what is right and what is wrong in a timely manner.
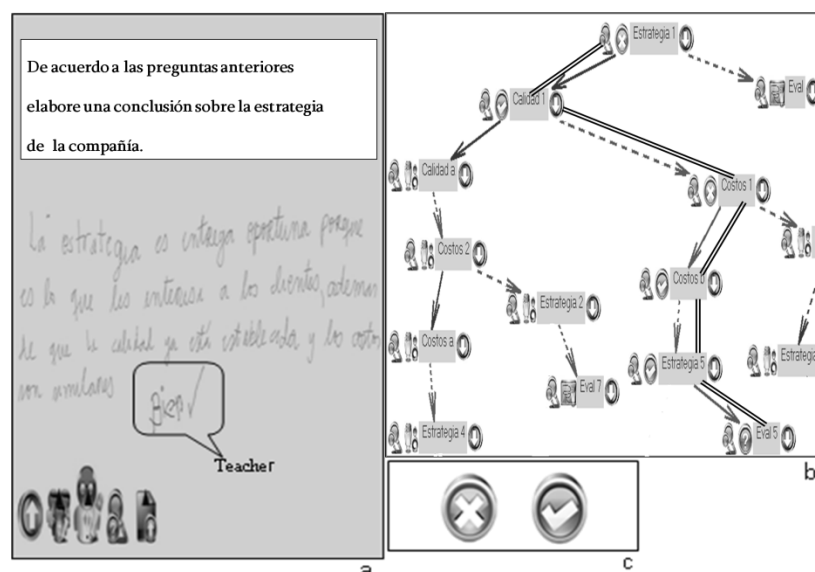
Figure 2. a: The teacher's comments on the student's answers are displayed on the student's screen. b: View of the questionnaire by which the teacher monitors the students´ performance. c: These symbols show if the student's answer is correct or incorrect.

In the view of the teacher, this component allows the observation, in real time, of the answers given by each student to each question, and when necessary, the teacher can make comments on these answers that the students receive immediately, as shown in figure 2a. Additionally, this component enables the storage of student performance data during the development of the cases, allowing the teacher to view the performance of students at all times, as this information can be accessed anytime and anywhere. Figure 2b shows the teacher's view of the performance of students (indicated by the double lines in this figure); an icon to the left of each question (see figure 2b) also displays if the student answered correctly or incorrectly, using the symbols shown in figure 2c. With this tool, the teacher will be informed on the process of the answers developed by the students and can intervene as needed, and the teacher can obtain an objective view of the performance of each student, allowing for better assessment of each individual.

Questionnaires: This component consists of a series of questions that the teacher poses and establishes relations and structures of binary sequences between the questions. Figure 2b shows these structures; here, each question has two arrows: one indicates the path for an individual responding correctly to a question (the dotted arrow), and the other shows the path if the answer is wrong (the solid arrow). In this way, students follow different paths when answering a question correctly or incorrectly because if the answer is incorrect, the structure of the questionnaire drives students toward reflective questions to encourage them to reach the correct answer by themselves. This functionality will allow the students to 1) evaluate their performance; 2) redirect discussions to science, evidence and the analysis of the case and so avoid losing the focus of the discussion; 3) communicate and negotiate more efficiently and so avoid wasting time due to wandering away from the topic; and 4) diminish their ambiguity when they feel uncertainty about their expected performance or the correct answers.

The teacher can design the structure of the questionnaire so as to ensure that the desired topics will be treated during the session in which the case is developed. This element contributes to planning the topics to be addressed by diminishing the possibility that they are not fully covered. Designed questionnaires can be used as many times as the teacher feels necessary, as they are stored in a file and are available at any time for use by different groups of students, helping to reduce the preparation time for each case.

Collaborative answering: This tool synchronizes the students of a group with the same screen and the same information. Figure 3a shows a group of students working collaboratively, and figure 3b shows the answer screen on which they are working; this screen consists of 3 divisions: the upper square contains the heading of the question, the middle square is the space where the students place their answers, and the square at the bottom contains the different responses. Students in the same group are automatically synchronized with this screen; when a student sends an answer, a box opens, as shown in figure 3c, where the symbol at the bottom indicates disagreement among members. This box also contains a traffic light, where the upper circle (a green light in the students' view) shows that 1 member of the group agrees with the answer, and the lower circle (a red light in the students' view) shows that 2 students disagree, as they chose different answers than the one of the student in the example. This component will enable the students to 1) improve communication and interaction; 2) agree to send

the answer to the teacher, although this cannot be done if there is no process for negotiation and argumentation by which the students can reach a consensus; 3) avoid discussions based on other kinds of information and prevent discussions from wandering; 4) encourage and facilitate collaborative work; and 5) reduce the time consumed in case development.

The three components described function jointly in the proposed prototype, enabling the teacher elaborate and allocate Questionnaires to students, who must use the Collaborative Answer component to solve them. During the time spent in the completion of the case, the teacher will use Online Assessment to provide constant feedback that students will observe instantly. Additionally, after the class has finished, the teacher can access the Questionnaires to observe the history of students' performance.

Figure 3. a: A group of students working with the prototype application. b: Screen for collaborative answering divided into three parts, where the members of the group are synchronized: the heading of the question is at the top, the students place their selected answers in the middle, and the answer choices are displayed at the bottom. c: Symbols indicating agreement/disagreement among the members of a group.

PROTOTYPE TESTING

A prototype test was performed with 34 students in the Models of Management Control course at the Universidad de Chile, consisting of fourth-year undergraduates. Students in this class were divided into an experimental group of 23 students who developed the case study using the prototype application and a control group of 11 students who developed the case without the use of this technology. The case study addressed the definition of responsibility centers in an organization as a fundamental element in facilitating strategy implementation; students were asked to respond to 4 open questions concerning 1) company strategy; 2) the key performances to be accomplished by key business units to implement the strategy; 3) the definition of key business units as responsibility centers; and 4) the suitability of that definition from the perspective of strategy implementation.

Additionally, the students performed two knowledge tests, one before (the pretest) and one three weeks after discussing the case (the post-test). Students in the experimental and the control groups were tested individually in the same manner; the aim was to measure the students' learning through the difference in scores between the pretest and post-test. Both the pretest and post-test used the same questions for both groups, which, as an alignment mechanism, consisted of three open questions on their knowledge of theoretical concepts about the definition of a responsibility center; each open question had a value of 33% on the final grade, given on a Likert scale ranging from 1 to 7. The teacher was available at all times to assist the students if required.

The group of 23 students in the experimental group performed a 30-minute training session on the use of the prototype. Subsequently, in the experimental session, each student was given a tablet PC with the prototype application installed; these tablets were wirelessly interconnected so that the members of a group could coordinate themselves in the development of the activity. The groups of students were asked to answer the 4 questions of the case; these were adapted to the prototype by the teacher before the session. These 4 questions differed for the experimental group in that the answers consisted of 3 alternatives, whereas the questions for the control group were open, without suggested answers.

The students' use of the prototype components and its impact on the critical issues were analyzed based on qualitative observations of the experimental group and the control group. Therefore, each group was assigned an independent observer, who took notes on the behavior of the participants with respect to the previously identified critical issues. The learning results were obtained through the quantitative analysis of the pretest and post-test,

where the degree of learning was calculated as the difference between the scores of the first and second tests; these results were then compared between the control group and the experimental group to assess learning differences in the groups.

IMPACT OF THE PROTOTYPE COMPONENTS ON THE CRITICAL ISSUES IDENTIFIED

The online assessment, questionnaires and collaborative answering components achieved the expected performance from a technical point of view. Overall, the prototype allowed for the discussion of cases through collaborative work in the classroom. The teacher stated that he would like to continue using the prototype in the future, which means that he felt comfortable with the use of this technology.

Our observations of student and teacher behavior in relation to the critical issues for both groups are summarized and analyzed in the following.

Participation: We observed that, on average, the components of the prototype seemed to promote more frequent and more effective participation among the students in the experimental group than among those in the control group. The collaborative answering component appeared to diminish students' resistance to participation (critical issue 1); each time that the group needed to agree on a final answer to submit to the teacher, it created the perception among students that each opinion was considered by the group. This need for agreement was not observed in the control group, and the presence of a strong leader in the group sometimes discouraged some students from participating. In contrast, it was observed that proper feedback, delivered by the online assessment component, significantly encouraged the students in the experimental group to keep participating (critical issue 3), whereas in the control group, students sometimes had to wait for the teacher to finish working with the group to receive feedback on their progress; this occasionally discouraged some students from participating. Finally, we observed that the questionnaire structure and the feedback provided by online assessment contributed to reducing the incidence of discussions among the participants of the experimental group that moved away from the facts presented by the case study (critical issue 2) in comparison with the control group.

Time required for case development: In most subgroups in the experimental group, students finished the case study several minutes before the end of the allotted time, whereas every subgroup in the control group was forced to discuss the last question quickly in an effort to finish on time. This suggests that the components of the prototype promoted a more effective participation by the students in the experimental group than the participants in the control group.

Ambiguity: The functionality of questionnaires, as well as the online assessment, seemed to reduce the sensation of ambiguity for the students in the control group. It was frequently observed that the questions asked of the teacher by the students in the experimental group were more precise than those in the control group; moreover, the feedback given by the teacher was better assimilated by the experimental group.

Difficulty for the teacher to act as a facilitator: There were no significant differences between the groups.

Difficulty for the teacher to evaluate student progress: The online assessment functionality enabled the teacher to acknowledge the progress of the students in the experimental group in real time by having access to their answers; therefore, he could provide more appropriate and precise online and face-to-face feedback. For the control group, assessing the progress of the students was more difficult, as the teacher could only access the students by face-to-face interaction.

In summary, the observations made in both groups suggest that most critical issues identified in the case methodology were properly addressed by the technological application designed for the preliminary test. A more definitive test should incorporate an instrument for measuring the perceptions the students regarding the impact of the critical issues on their performance.

IMPACT OF THE USE OF THE PROTOTYPE ON LEARNING

The learning results, calculated as the difference in the scores of the post-test and pretest, were compared for the experimental group and the control group; the difference of the means was tested using the Bootstrap Method. This method allowed us to artificially reproduce the sample of the control group (11 observations) to compensate for the difference in sample size between the control group and the experimental group, enabling the comparison of the means for both groups. The results achieved suggest that the difference between the means was significant with a confidence level of 10% (p=0.093), where the learning was higher in the experimental group (with a mean pre- and post-test score difference of 1.6) compared with the control group (with a mean difference of 1.2). These outcomes suggest that improved learning results can be achieved when using the proposed application prototype; nevertheless, given the level of significance, it will be necessary to create a new experimental scenario that will allow for improved collection of data for the corresponding analyses.

CONCLUSIONS

Based on a review of the existing literature on case studies, we extracted and organized a series of steps that constituted an organizational scheme for developing this methodology that is useful for both the teacher and the student. We thus identified and consolidated the advantages and critical points that this methodology may present

in the learning process. These issues enabled us to clarify the conception of case studies and allowed us to evaluate the feasibility of implementing this methodology in the classroom.

With regard to the critical issues, we identified the general requirements for addressing the identified problems so as to access the advantages of the case study methodology, summarized as the need to support the collaborative process among students, provide feedback to increase participation, use planning tools and reuse materials. Based on these general requirements, we designed 3 main components (online assessment, questionnaires and collaborative answering) and incorporated them into a prototype application designed for a tablet PC. This application allowed the incorporation of this technology into traditional teaching methods, a relevant fact given the possibilities afforded by technology to strengthen the positive effects of these methods (Jipping et al. 2001). Regarding the case study methodology, the use of this technology may favor the acquisition of skills important in the 21st century.

The prototype application was subjected to preliminary testing and functioned correctly, allowing the development of case studies. We found that the proposed application components facilitated the elements of collaborative work and positively impacted the majority of the critical issues identified, promoting participation, decreasing ambiguity and allowing the teacher to provide formal and informal feedback to the students and in turn provided the teacher with more information with which to assess student performance. This conclusion is corroborated by the observation that the control group encountered several problems in focusing the discussion on the evidence of the cases, in reducing the ambiguity perceived by the students, and in the ability of the teacher to provide feedback to the students. These results motivate future work aimed at determining whether these application components minimize the appearance of critical issues that limit the effectiveness of case study methodology. It is expected that further testing may incorporate improvements to the prototype components to make it easier to use and improvements in the experimental methodology to better evaluate how the use of the proposed application improves student learning.

ACKNOWLEDGMENTS

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TOPIC 6: Assessment for learning with mobile devices

Long Papers
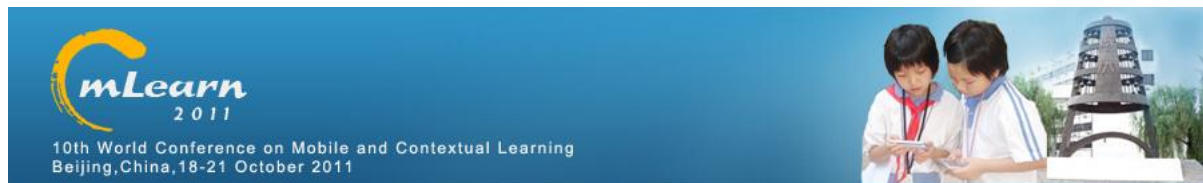
Assessment of Non Functional Requirements in Mobile Learning

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ABSTRACT

Quality Engineering is a new paradigm playing a crucial role in the European market of Services and Applications. In this field the assessment of Non Functional Requirements (NFRs) is underlined as an important step to have time-to-market products satisfying the quality and user needs. We aim to define a methodology and a representation of NFRs for assessment and traceability management. This will be based on creation of semantic networks for deliberation and argumentation among different stakeholders, who can be involved in the assessment of quality features, by using techniques from Software Engineering and Quality Management, as well as hypermedia discourse and dialogue mapping from HCI. Further research is how to relate NFRs to architectures. This will be addressed by using Problem Frames, which provides a mean to analyse and decompose a problem in a problem domain rather than to drift soon into the solution space (architectural structures), until a good understanding of the problem is gained in the domain.

Author Keywords

non-functional requirements (NFRs), mobile learning contents (MLC), system architectures

OBJECTIVES

The Educational and Mobile worlds are converging. Consider a scenario such as the training of First Aiders within the Open University (OU) who have to deal with incidents around the campus, in addition to their normal job role (McAndrew et al., 2010). At drastic incidents, such as heart attacks, it is critical for these volunteers to take immediate and appropriate action. Therefore they need training to get a better feel for what it might be like to deal with an incident in reality. Mobile technology offers new possibilities for providing stimulating training exercises, conducted in situ (rather than in an assembly hall, or other meeting place), and the high-quality design of the trail aimed to address this issue: users would be faced with challenges and would need to draw on knowledge, collaborate together and communicate to meet those challenges. The EU-funded MOBILearn project successfully identified a need to use such scenarios to obtain user requirements in the user-centred context through field studies (Taylor and Evans, 2005).

In such mobile learning scenarios, high variability of individual users lies in the application contexts, user profiles, skills and preferences. This high variability remains a challenge to evaluate the educational value of various learning materials available to a mobile user (e.g., on the App Store and the Web). Research on the quality or non-functional requirements (NFRs) plays a key role in selecting the most appropriate applications for different stakeholders' goals (Liaskos et al, 2006). Few research projects on NFRs trace the variability in goals to the variability in contexts and design (Nuseibeh 2001, Salifu et al, 2007), which are crucial to most mobile learning cases. Mobile learning adds intrinsic complexity to software engineering because it involves interacting both with software that runs on a mobile devices and with educational resources that may be obtained by using the software. Evaluating both aspects is very different from evaluating any traditional educational resource such as books because of the interleaving aspects of software and learning resource. The blurred distinction between software and supporting learning complicates the assessment of its educational effectiveness as well as the educational purpose underlying the design of the software. Further, it is difficult to develop predefined standards against which to assess the educational value of the software, because there is not a unique and general instructional approach. Thus, the educational value of mobile learning is very difficult to define in practice.

To address this challenge, our research on traceability of NFRs in Mobile Learning has two objectives. Tracing to the external factors, objective one is to assess the educational value in mobile learning by tracing users' NFRs

to observable contextual behaviour of the Mobile Services and Applications (MSAs), including the interacting devices, the user profiles and functional requirements; tracing to the internal factors, objective two is to justify the architectural design choices amongst large available MSAs according to the important NFRs for mobile learning.

Objective 1. Tracing NFRs to contextual factors and making them exoskeletal. Unlike Functional Requirements (FRs) that prescribe the solution expected by a user, *NFRs*, such as usability, privacy/security and mobility, prescribe the quality attributes that are important for users to select from among solutions of the same functionality. Many external factors can influence the users' quality judgement, including the fitness of the running context, the satisfaction of users' skills and preferences. As such, contextual factors play a major role in evaluating the quality of systems especially because mobile learning systems interact more directly with end-users. Mobile learning systems represent a broad class of software systems with complex characteristics that tend to make the one-size-fits-all evaluation difficult, also because there are no existing comprehensive frameworks for formative evaluation in the mobile environment, only limited frameworks have been developed for evaluation in specific contexts such as school field trips, museum visits or vocational training. The project will contribute mainly to the current state-of-the-art in providing methods and procedures to make the NFRs '*exoskeletal*', i.e. visible and tangible to the external users of software systems.

Objective 2. Tracing NFRs to architectural design factors and making them monitorable. It is widely recognised that early identification of architecture can assist in elicitation of detailed requirements, in design and reuse. Further, MSAs development environments are usually populated with new technologies, tools and paradigms, which generate new NFRs and architectural styles in the MSAs domain. The research will assess important NFRs against mobile learning architectural decisions and externalise controllable tuning parameters. By delaying a design decision to the runtime, the research aims to give end-users more freedom in reconfiguring the MSAs for the particular needs, especially in drastic urgencies. Hence, feedback collected from monitoring the changed NFRs can propagate to the MSAs architectures, making the mobile learning more adaptive to the changing needs of end-users. The research aims to support traceability of NFR to the software architectures by applying Quality Function Deployment (QFD) to assure that the user requirements, especially the NFRs, are traced in all development stages and thus sufficiently supported in the final system. This will place the "*generation of a value model*" such as is used in classical engineering disciplines, at the centre of the development, achieving a model of what is valued in the resulting system. As a result, quality characteristics are no longer externally imposed on a development process but "*constructed*" within it. Implementing this concept in the scheme to represent NFRs traceability contributes to leverage this research project at a high scientific and technological level in the current "state of the art".

Multidisciplinarity aspects of this project address several R&Ds fields, such as software quality, requirements engineering, software architectures, domain modelling, software maintenance, information retrieval, artificial intelligence, human computer interaction and human learning. These aspects are related to the schema for tracing the NRFs to architectures given in the next section.

Our research novelty is to apply the research methodology of NFRs to a critical domain for future time-to-market applications, such as MSAs to e-learning. The results can be extended to mobile services in different sectors (automotive, health care, procurement, etc.). The main result of our reserch is a quantified NFR traceability to mobile learning contexts to facilitate the evaluation of educational values of MSAs.

Section 2 describes our approach and First results
Section 3 outlines further research
Section 4 concludes the paper.

APPROACH AND FIRST RESULTS

Mobile e-learning is relatively new, so we are only beginning to see the potential of mobile devices in training and performance support. Mobile devices are small, portable and compact. They can often fit in a pocket or purse. Unlike laptop computers, which are expensive, heavy and power-hungry, mobile devices are relatively low-cost, lightweight, and some work for a long time on an electrical charge or using a couple of standard disposable or rechargeable batteries. The small screen size of mobile devices (an NFR) makes some people question their worth as e-learning delivery tools. Some of these devices have good audio capability, allowing students to listen to a narrated lecture, rather than read material on a small screen. However, some critics do point to the restricted input capabilities (another NFR) of some of these devices, questioning students' ability to enter large amounts of text into a device to take notes or answer an essay-type question. Many of these devices are, however, extremely adaptable (again, an NFR) and can be attached to a full-size folding keyboard that makes entering large amounts of information every bit as fast (another NFR) as it is with a conventional computer.

Our approach is based on the evaluation methodology adopted in the ESPRIT project ERMES (Avellis and Ulloa 1997) consists of identifying aspects of the object under assessment, and then defining quality indicators in relation to these aspects. Defining the object of assessment is a key step, because it suggests the evaluation criteria to be used. We group the characteristics of multimedia educational software under the following four evaluation categories:

- educational features
- technical features
- aspects relating to the ease of use (usability)
- aspects relating to the content.

Features of mobile learning :contents (MLC) include the:

- content to be taught
- delivery media used to provide information
- user interface the way the educational software presents itself to the user; interaction devices by which the user interacts with the computer, making choices, answering questions or performing activities, and is provided with feedback to each response
- instructional strategy adopted
- access which refers to the navigational paths available to the user to reach the needed content
- navigation allowing the user to go from one piece of content to another
- presentation which can provide guidelines for defining the visual communication strategies or presenting the content, navigation strategies and operation to the user
- user operation those operations that are visible to the users and the only ones the user must be aware of
- system operation that are not visible to the users, but are essential in building user operation (Avellis and Capurso 1999a; UWA Consortium 2002).

Techniques are needed to express NFRs, which include quality requirements (Finkelstein 1994). The scheme developed to express NFRs is based on the work done by Kunz and Rittel (1970), particularly in the area of design rationale (Potts and Bruns 1988). We also take into account the 'issue-position-arguments' model (Conklin and Begeman 1988). In our scheme, an 'issue', that is a problem to solve, is an 'NFR, or quality characteristics/sub-characteristics to evaluate'. An 'argument', that is, a supporting justification of the issue, is a *procedure* that helps to determine which design alternative to choose to implement in the related NFR. Finally, a 'position' that is a solution to the problem, is either a 'statement' of the NFR, which gives a quality goal to be supported by the final design, or 'design alternatives'. A statement is an ascertainable property (possibly measurable) characterising NFRs. The set of links is given in Figure 1

It is important to underline that the statement contains measurable elements by which the NFR can be 'constructed' in software systems. It is a procedure that applies to different architectural choices. In this way we relate NFRs to architectures, by linking statements and different system architectural choices.

We have enhanced the representation of NFR with quality function deployment (QFD) features. Since the late 1960s Mizuno and Akao (1978) have established a new systematic method of design-oriented approaches to ensure that customer needs drive the product design and production process. They developed a method called 'quality deployment and/or quality function deployment' (QD/QFD). We have enhanced the scheme of NFR representation by introducing the context of evaluation and weights to the links as follows. To be assured that we will achieve a particular software quality characteristic it is helpful to associate it with some activities within the software evaluation and development process. *Activity* is the evaluation and/or implementation activity of the quality characteristic that provides the context of evaluation. A quality characteristic is obtained in a *strong/medium/weak/negative* way as a result of performing an activity

In a quality-function-deployment (QFD) style we attach some weights –strong/medium/weak/negative – to this link, to let the end users (teacher, trainers, students, administrators) assign a weighted value to the characteristic of the system under evaluation.

Many national and international activities in mobile learning contents (MLC) and in multimedia educational software (MES) in general are currently partially funded by the European Commission, involving private and public sector organisations (Avellis and Fresa 1999). In this context, the need for educational multimedia for vocational training purposes is widely recognised. However, users of educational multimedia cannot appraise educational resources because they are not able to evaluate their characteristics, potentialities and limits (Avellis and Capurso 1999a).

Although a quality characteristic can be constructed independently of the description of the development process of a product, it is useful to link the product and process descriptions to the quality characteristics. Avellis (2000)

provides insights into how to relate this process view to a product view, by introducing the role played by the architecture of a software system and relating it to the NFRs. Although a quality characteristic can be constructed independently of the description of the development process of a product, it is useful to link the product and process descriptions to the quality characteristics. We introduce the explicit representation of architecture in the annotation scheme of NFR given before in order to set a link between the process view and the product view of the software system under evaluation. The complete scheme for the representation of the links between NFRs and architectures, provides the explicit representation of the architectural description of the software system and new links to architecture and statement (position) and procedure (argument), as follows:

- *supports (*a statement is grounded on the specific choice of an architectural description and upkeep it. It becomes obsolete if the statement/position changes in the software system. An architecture can be chosen as the alternative which satisfy the statements in strong/medium/weak or negatively way, following the QFD style);

- *applied-to (*a procedure has to be implemented by the related architecture, that is the architecture accomplishes or neglects a given procedure both formal or informal, which can also be provided as argument during the evaluation to improve the current software system)This link is useful for several purposes such as reuse of design and requirements, reuse of design decisions and related architecture, explicit representation of rationale of an architectural description, evaluation of the architecture of a software system with respect to the non-functional requirements (Avellis, 2000). In the following, we illustrate some examples.

Here are two examples of the application of the scheme above to MLC and MES.
An NFR related to a MLC could be: 'the MLC should fit the subject/topics and learning objectives of my course'. The activity related to this example is to: 'evaluate the educational aim of the MLC package', which strongly achieves the quality characteristics' 'educational features'. 'Educational features' quality characteristics have several sub-characteristics to be taken into account, such as 'instructional characteristics', which suggest by their requirement statement that 'appropriateness of learning objectives are suitable for the age and competence of target users' and this is measured by a procedure to 'verify that the content and learning objectives are consistent with the national curricula requirements'
The second example is the NFR 'the MES package should be easy to operate'.The activity related to this is 'understanding the usage of a MES package', which achieves in medium form the quality characteristics of 'usability'. This in turn can be further specialised into the sub-characteristics 'ease of use', which is suggested by the requirements' statement 'the way software operates' and several procedures are used to measure usability: 'What are the IT skills required to operate the software? Is on-screen help available? Are directions clear and accurate? Are directions available at all times? Is the management of assessment instruments easy?
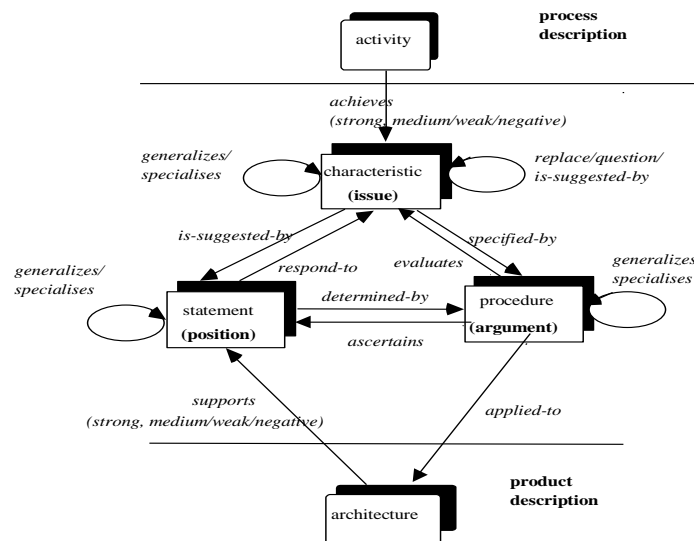

Figure 1 - Non Functional Requirements Representation Scheme to Architectures

FURTHER RESEARCH

The methodological approach to further research in order to achieve the objectives above is described as follows:

Objective 1 – Tracing NFRs to contextual factors. Assess the NFRs of several applications in the domain of MSAs, obtaining general NFRs by mixing direct and indirect elicitation approaches. The elicited NFRs have the advantage to be analysed following Software Engineering (SE) best practices, such as goal-decomposition. The proposed evaluation methodology consists of identifying the goals under evaluation, and then defining quality indicators in relation to these goals. Defining the goals of evaluation is a key step, because it suggests the evaluation criteria to be used. Using the Problem Frames approach (Jackson, 2001), the characteristics of contextual factors in relation to the goals of mobile learning (i.e., context diagrams) can be grouped in categories, and sub-categories, such as educational features and usability, and will be extended for addressing communication and interaction aspects, as well as the constraints of handheld mobile devices.

Objective 2 – Traceability NFRs to MSAs architectural design - Assess the architectural decisions in existing MSAs systems (e.g., from the MOBILearn project), analyse how the documented architectural styles in the literature support the NFRs of MSAs domain, and deploy NFRs monitors to collect end-users feedback. This can be a difficult task in the mobile domain because the architectures of MSAs are usually not represented explicitly. The best approach is to identify them by comparison with documented architectural styles in the literature. The aim is to investigate MSAs with similar NFRs and architectures, and to search for evidence whether there are common challenging ones that characterise the chosen domain. Based on these results, the project will develop a lightweight but effective method to address the evaluation of style suitability for fulfilling NFRs, based on innovative techniques from quality management and design rationale. Finally, the research will design a novel scheme for representing the traceability of NFRs, in particular focusing on the links between NFRs and architectures, by using semantic hypertext representation and the most innovative techniques from HCI, and the monitoring and diagnosis theory in AI. The method to analyse the suitability of architectural styles, which fulfil a given NFR, is an important project result, which can serve a broader community including e-learning planners, managers, architects and developers. The architectures of MSAs will be shown to exhibit characteristics of various architectural styles. By analysing how these styles support the NFRs, the project can identify those styles that offer the "best-fit" and provide guidelines for the engineering of MSAs.

Validation of this approach will be carried out by conducting key case studies in Europe. This has the advantage to test the evaluation and traceability of NFRs in industry and SMEs interested to exploit the project results with respect to their applicability in the near future time-to-market products. Feedbacks will be taken into account from the case studies to improve the evaluation methodology, the scheme and methods above.

CONCLUSIONS

This paper presents work in progress to improve the current assessment methodology based on the first results of the framework of the ESPRIT project ERMES. The key issue is how to incorporate in the scheme the architectures to annotate NFRs to MLC. Further research is needed in this context as discussed above.

The innovative nature of this research is to apply evaluation and traceability methods and techniques from Quality Management, Software Engineering, Educational Technologies and HCI to a critical domain, such as MSAs to e-learning.

This implies some *interdisciplinary* elements to be taken into account during the research, especially to address the mobile and the educational features, in which the NFRs are very difficult to define in practice and to cope with, during their development and use in educational settings. Despite the amount of discussion, little research effort has been devoted to techniques to support both assessment and traceability of requirements, especially quality requirements, in m-learning. Since the start of the current millennium, experience and expertise in the development and delivery of mobile learning have blossomed and a community of practise of mobile learning has evolved that is distinct from the established communities of e-learning. This community is currently visible mainly through dedicated conferences. So far, these forms of development have focussed on short-term small scale pilots and trials in developed countries in Europe, North America, and the Pacific Rim, and there is a taxonomy emerging from these pilots and trials that suggests tacit and pragmatic conceptualisations of mobile learning. However, what has developed less confidently within this community is any theoretical conceptualisation of mobile learning and with it any evaluation methodologies specifically aligned to the unique attributes of mobile learning. Some advocates of mobile learning attempt to define and conceptualize in terms of devices and technologies, other advocates do so in terms of mobility of learners and mobile learning, and in terms of the learner's experience of learning with mobile devices. The increasing diversity of mobile education and the increasing power, sophistication, and complexity of mobile technologies call into question the adequacy of the conventional repertoire of assessment techniques based largely on formal and traditional learning. There is a need for a more comprehensive and structured approach to assessment based on sound and transparent principles. There are a variety of problems associated with assessing mobile learning, where the most fundamental problem is defining the characteristics of a good or acceptable assessment, though, of course, the issue of assessing mobile learning will also take us back to the issue of defining and conceptualising mobile learning. Our research aims to enhance the current "state of the art" by developing a representation scheme to evaluate and trace the requirements based on a design rationale and argumentation, and addressing increasing awareness of information, requirements evolution history, explanation, justification and change management, at a high technological level of the ongoing modelling, design and implementation techniques. Our research will take a process-oriented view vs. current

product-oriented views, being influenced by the work of decision support systems. The research approach aims to extend the model for representing design rationale by making explicit the evaluation goals presupposed in the argument of the rationale representation, and providing the means to improve the quality of the system.

In the long-term future of Requirements Management Tools, it is emerging that the selection of a suitable architecture for a system is critically dependent upon the NFRs. Further, in the current "state of the art" of Requirement Management, the requirements are not organised so that the impact of changing a requirement on other requirements or on the system design can be determined. It is widely recognised that NFRs are crucial in software development and that different architectural choices can have different impacts on the quality of the final system. However, there is a gap in the way current software development methods build and keep track of the links between requirements, especially NFRs, and architectures used in constructing and evolving complex systems. The aim of the project is to provide an explicit mapping between the NFRs and the systems and use the map, respectively, to reason on the "value" of a system, and to incrementally evaluate the NFRs during software development. Further research will be performed to investigate the enabling technology to explore in this context the reuse of design, which leads to identify which components and relationships in the architecture satisfy the requirements, which architectures can be reused in an evolutionary change process, and which parts need incremental changes to derive improvement in the architectural artifacts.

The originality of the research is that here the research will focus on the high level part of this process, that is the analysis and reasoning on the process of building a "value" model of a software system, by explicitly adopting design rationale and quality management techniques to represent on NFRs.

The relationship between NFRs and architectures is an area of active enquiry research in the wider Software Engineering community. This project aims to contribute to this discussion and enhance the current "state of the art", by introducing novel approaches to represent the traceability links between NFRs and architectures, impact analysis of changes to NFRs to architectures, and finally a method to evaluate MSAs for e-learning, and the suitability of architectural styles of MSAs with regard to NFRs.

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Accessing Mathematics through Mobile Learning Devices for Students with Learning Difficulties

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ABSTRACT

Advances in technology are useful to educators if they can be applied in a practical and appropriate way to change daily instruction. A mobile learning device (MLD) is accessible technology that can be used to enhance mathematics instruction. Previously, students with learning difficulties found accessing the general education curriculum challenging. This study investigated the effectiveness of MLDs in mathematics instruction for typically performing students and students who have Individual Education Plans (IEPs). The findings of this study suggest that the integration of MLDs as a learning tool into classroom instruction is beginning to have a positive effect on mathematics instruction for all students, including those with IEPs.

Author Keywords

Mobile Learning Devices, Special Needs, K-12 Education, Higher Education

INTRODUCTION

Recently, the popular press and academic literature have published numerous articles concerning the use of mobile learning technology in K-12 learning environments (Franklin & Peng, 2008; Liu, 2007; Traylor, 2009). While the topic has been debated in several publications, there is a paucity of research on the effectiveness of this technology on learning and student achievement (Dick, 2008). This study investigates the effectiveness of using mobile learning devices (MLDs) as a learning tool for all children in the general education classroom. We analyzed the results from standardized tests with special attention paid to students with Individual Education Plans (IEPs) that included mathematics goals from a small school district in northwest Ohio who has been using MLDs for the past two years.

The technology mission statement for the participating school system is focused on creating life-long learners (Menchhofer, Sommer & Riepenhoff, 2009, p. 4):

1. Technology creates a global learning environment.
2. The use of technology encompasses all learning styles.
3. Technology provides motivating and collaborative experiences.
4. Technology facilitates self-discovery for all learners.
5. Technology can transform the roles of teacher and learner.

The participating school system's primary technology goal is to sanction the use of technology as a transparent tool, "Infusing technology into the classroom instruction will create the students who are academically competitive, technology literate, motivated and engaged in the learning process. The students will be proficient information users who have the ability to access, process and effectively communicate information in order to improve their learning and exceed in the national educational standards." (Menchhofer, Sommer & Riepenhoff, 2009, p. 4).

President Barak Obama's administration has set two educational priority goals: a) raise the proportion of college graduates from 39% to 60% and b) close the achievement gap so that all students graduate from high school ready to succeed in college and careers. To achieve these goals, the recent draft of the National Educational Technology Plan (USDE, 2010) suggests that education must undergo "revolutionary transformation rather than evolutionary tinkering" and emphasizes the importance of leveraging technology "to provide engaging and powerful learning experiences, content, and resources and assessments that measure student achievement in more complete, authentic, and meaningful ways" (p. v). The technology

plan recommends all students learn with digital technology in school and at home through a 1:1 computing approach using cell phones, laptops, and other mobile learning devices (MLDs). "More than half of the world's population now owns a cell phone and children under 12 constitute one of the fastest growing segments of mobile technology users in the U.S." (Shuler, 2009, p. 4). Put bluntly, this reality is forcing educators to MLDs as potentially useful tools for students to better understand curriculum concepts as well as to stimulate student efforts to collaboratively problem solve (Ash, 2009; Manzo, 2009).

In the United States, the leading technology and math organizations (ISTE, 2007; NCTM, 2000) recommend teachers and students improve the teaching and learning environment through the use of technology. In the 21st century education model, students bring technological knowledge into the classroom, and teachers help to process, acquire, access further, analyze, and translate that information into useful knowledge outside the classroom (Prensky, 2008). Students are empowered with technological knowledge and the ability to access information, whereas the teacher's role is to facilitate students understanding and refinement of the accessible information (Prensky, 2008). Learning to implement the 21st century curriculum involves consistent use of technology, a skill teachers need to become proficient and convey in the learning environment (Freyvaud, 2008; Prensky, 2006a; Zbiek, Heid, Blume, & Dick, 2007).

Similar sentiments are expressed outside of the United States. In Finland, the HandLeR is a project undertaken at the Tampere University of Technology where MLDs are used for K-12 mathematical education. The use of games is a way to promote collaborative learning inside and outside of the classroom and a method to measure the students' mathematical knowledge (Ketamo, 2002). Comparable research was undertaken in Taiwan, where students were equipped with network-connected MLDs and had their class work transmitted to a whiteboard. The findings suggest when compared with traditional classrooms, virtual learning environments can increase the levels of student participation and promote collaboration among the students' and higher levels of teacher-student interactions (Liu, et.al. 2002). In Hong Kong, grade four students used MLDs to access a web based cognitive tool, Interactive Perimeter Learning, for calculating the perimeter of irregular 2-D shapes. The findings from this study suggest that using the tool increased the students' understanding of perimeter due to the students' ability to manipulate line segments of the shape's border (Kong & Li, 2007). Recently, an international empirical review of the literature was conducted on the use of MLDs in K-12 and higher education settings. The authors' found that: (1) mobile handheld devices are most commonly used by students and teachers as communication and multimedia access tools; (2) descriptive research is the dominant type of research methodology; (3) there is no significant difference in terms of test scores achieved by students using MLDs and paper and pencil based assessments; (4) the majority of the research suggest that students' learning is enhanced through the use of mobile handheld devices; (5) the majority of the studies emphasized how students use MLDs, rather than a theoretical rationale or justification for using them; and (6) several studies indicated that the high cost of using MLDs hinders the use of the devices in more educational settings (Cheung & Hew, 2009).

Today, many educators face a technological dilemma. On the one hand, schools promote the use of technology, specifically school district approved technology (Smart boards, calculators, and laptops). However, on the other hand school districts create policies forbidding the use of mobile technology on school property. These policies ignore the learning potential of the relatively inexpensive MLDs that are an integral part of the daily lives for a majority of students. School systems view MLDs are as barriers to students' learning. In the contrary, MLDs used daily can become an effective learning tool for typically performing students and students with special needs. The researchers purport that MLDs provide a crucial link that engages a typically marginalized group of students, children with learning difficulties. The purpose of this paper is to examine the effectiveness of MLDs in students' learning of mathematics, as well as to compare the effectiveness of MLDs in mathematics instruction for students with and without IEPs.

THEORETICAL FRAMEWORK
Technology and 21st century students

The Pockets of Potential (Shuler, 2009) highlights five opportunities to seize mobile learning's unique attributes to improve education:

- Encourage "anywhere, anytime" learning;

- Reach underserved children;

- Improve 21st-century social interactions;

- Fit with learning environments; and

- Enable a personalized learning experience.

The first step in accelerating student academic success is to understand the role the student plays in the learning process. By observing and discussing with students about their needs; their thoughts about learning are important data when determining the particular technologies to be used in classrooms. Teachers and students need to be active partners in the design, as well as participate as informants in the testing and redesign of content (Druin, 2002). Engaging teachers and students from the beginning of the technology-content process allows for a greater chance to increase learning achievement, especially when the adults' and children's perspective are included in the redesigned content based learning modules (Lim, 2008; Prensky, 2008a). Teachers need to evolve in their roles as technologically advanced content facilitators if they wish to successfully teach 21st Century students.

MLD technology levels the learning field, because they are a relatively inexpensive, accessible technology for most households, including those households that lack laptops or desktop computers and internet connections. Students with learning difficulties generally have the same access as typically performing students. Even the students, who have not had consistent access to technology at home, are still part of the "digital natives" generation, because of their consistent exposure to the vocabulary and information associated with almost instant access to information (Prensky, 2006b).

Students with Learning Difficulties

Students with special needs in the United States, especially those with identified learning disabilities, are expected to participate in the general education classroom (NCLB, 2001; IDEA, 2004). Often these students are not motivated to attempt the curriculum that has repeatedly caused them to have issues in their learning. The US National Council for the Teaching of Mathematics (2000) maintains that "technology offers teachers' options for adapting instruction to special student needs" (p. 25) and that a technology enriched learning environment would be beneficial for students with attention and organizational issues. When used effectively, MLDs provide a transition for these into the curriculum. Initially, teachers must examine their teaching behaviors and explore how teaching with technology opens up modification and accommodation options, before utilizing technology adaptations in the learning environment.

This process needs to include specific professional development that begins with technology facilitation training, rather than teachers' random attempts to insert the technology into their classrooms (Kimmel, et. al, 1999). Making technology a useful and transparent part of the classroom was a goal for the school system's technology coordinator and planning team. This means that technology is embedded in the students' daily lives inside and outside of the classroom (Liu, et. al, 2003). Technology can reduce the time spent on repetitious and unnecessary work. Tedious work to the typically performing student often is the roadblock that stops the momentum of the student with learning difficulties. Technology engages students in learning activities; especially group learning, which allows the students' strengths to be realized. Technology infused learning allows for archiving information in files or portfolios and more accuracy in monitoring of students' progress throughout the lesson (Liu, et. al, 2003). The short term goals of technology use include engagement in instruction and access to the curriculum for all students. The long term goal is to assist all students, especially students with learning difficulties, to realize their potential as active members of the community and workforce.

Teachers must first identify the areas that the students are struggling with, such as computation, and then they can apply needed modifications (Peltenburg, van den Heuvel-Panhuizen & Doig, 2009). The MLDs at the participating school were available to all students included in the general education mathematics classes. The special education teacher was a co-teacher and co-planner with the regular teacher and made sure the needs of all students on an IEP were being met in the regular classroom. Most students were comfortable using the MLDs. The special needs students needed very modest modifications such as a larger screen, so that the print appeared on the monitor and, therefore, larger. Other modifications to the MLSs were more pedagogical, such as having fewer problems to solve or the availability of formulas as references to solve the problems. Observing the students in a regular classroom setting, it was evident that the special needs students were captivated by the MLDs and appeared to have minimal frustration when challenged to learn difficult mathematical concepts.

METHOD
Data collection

This study investigates the effectiveness of MLDs in students' learning of mathematics, both typically performing students and students with IEPs, by analyzing students' performance on the SUCCESS test (https://reports.success-ode-state-oh-us.info/Login.aspx). The SUCCESS data analyzed in this study are provided by the Ohio Department of Education for dissemination of test data to the schools. Since student SUCCESS data is password protected via the educators' workroom link, the authors did not have a direct access to the data. The participating school district removed students' names and provided three years of SUCCESS data, 2007 - 2009 to the authors. The academic year 2008 was a pilot year, the first year for the participating schools using MLDs. Prior to the introduction of MLDs and throughout the study, the participating teachers taught the same grade levels, remained in the same school building, and math curriculum remained the same. The six teachers in grades third through fifth used MLDs in order to pilot test the effectiveness of the devices in education. In 2009, the second year, all the students used MLDs in grades third through sixth from two elementary schools and one middle school. More than 600 students used the MLDs daily, and their SUCCESS data were analyzed in the study.

Data analysis

The Spring SUCCESS data, 2007, 2008, and 2009 are analyzed using the following variables:
- The mathematics scale score,
- The raw scores for the state five content standards: Measurement; Number Sense and Operations; Patterns, Functions, and Algebra; Data Analysis and Probability; and Geometry and Spatial Sense, and
- The math total raw scores.

The descriptive analysis for the whole population is followed by the descriptive analysis comparing students with IEPs and the non-IEP student population. Due to the size and the nature of the sample, t-test for independent groups is used to compare students' scores for different years for IEP and Non-IEP student populations separately. Since students were at different grades each year taking different tests, they were treated as independent groups.

RESULTS

Table 1 summarizes data for the mathematics scale score, individual raw scores for five content standards: Measurement, Number Sense and Operations, Patterns, Functions, and Algebra, Data Analysis and Probability, and Geometry and Spatial Sense.   All mathematics scores for the whole population are also included.

Table 1. Descriptive statistics for the whole group across three years

	2007		2008		2009	
Whole Group	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Math Scale Score	427.05	33.737	427.75	36.597	429.54	31.654
Measurement	55.38	21.581	56.21	22.612	56.48	19.946
Number	101.27	30.966	90.97	32.496	103.20	32.001
Algebra	58.26	22.380	63.04	25.940	64.14	22.266
Data & Probability	59.72	22.549	62.32	20.119	59.76	22.697
Geometry	59.76	20.126	60.80	21.772	65.66	16.878
Math Total Raw Score	334.39	98.170	333.34	101.132	349.25	91.738

The average of total mathematics score for 2009 is higher than the other years.   The mean score for the mathematics scale score in 2009 is higher than the other years.   Mean scores for Measurement, Algebra, and Geometry gradually increased over the three years, but Data analysis and probability mean score does not show improvement.   Mean score for Number and Number sense increased in 2009, but 2008 score was much lower than 2007.   In contrary, mean score for Data analysis and probability show a noticeable improvement in 2008 but no increase in 2009.

Figure 1 provides a comparison of the data for students with and without IEPs for the mathematics scale and the total mathematics scores for 2007, 2008, and 2009 combined.

	Measurement	Number	Algebra	Data & Probability	Geometry
■ Non-IEP students	59.73	104.88	65.92	64.47	65.58
▪ IEP students	35.61	63.68	38.78	39.26	42.47
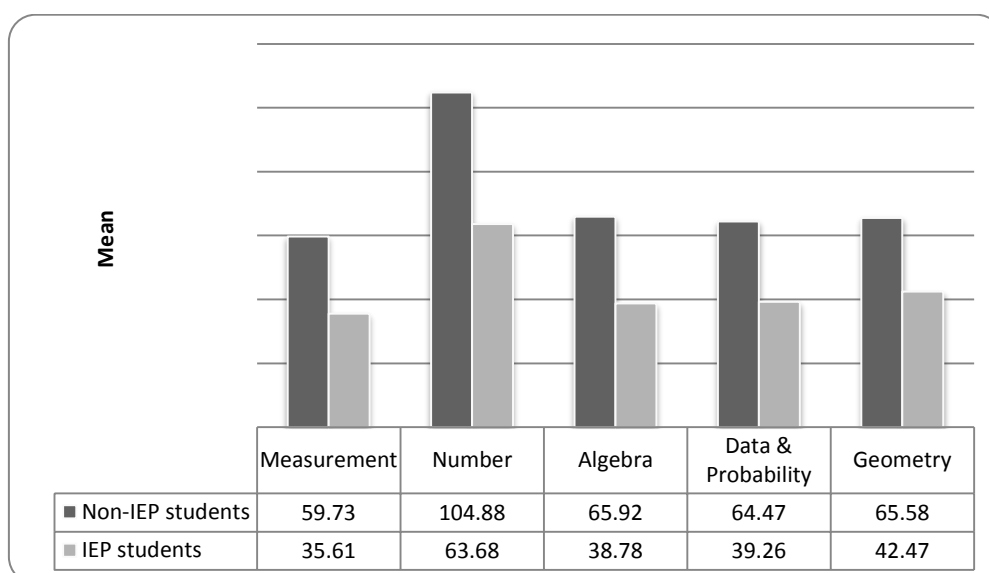
Figure 1. Comparison of IEP and Non-IEP populations

Approximately 16 percent of the whole population is composed of students with IEPs.   As predicted, their scores compared to Non-IEP students are lower in all areas.   However, this result can inform teachers with an overall picture and help diagnose where the biggest gap exists between students with and without IEPs.   The ratio of students with IEPs and students without IEPs is different for each content standard.   The biggest gap between students with and without IEPs appears in Algebra and the least difference in Geometry.   Considering the new nation's emphasis on Algebra in high school graduation requirement (Achieve, 2009), early intervention in Algebra needs to be discussed between mathematics and special education teachers, especially ways to use the MLDs in Algebra instruction.

Table 2. Comparison of IEP and Non-IEP populations across the years

	2007				2008				2009			
	Non-IEP Students		IEP Students		Non-IEP Students		IEP Students		Non-IEP Students		IEP Students	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Math Scale Score	434.46	28.985	389.13	30.841	435.47	32.336	385.54	29.071	435.51	28.212	394.08	27.633
Measurement	59.18	19.848	35.96	19.632	60.60	20.244	32.16	19.644	59.44	18.361	38.89	20.025
Number	107.83	26.081	67.71	32.336	97.63	28.879	54.54	26.576	109.01	28.310	68.67	31.020
Algebra	62.62	20.178	35.96	19.726	67.95	23.683	36.19	20.889	67.36	20.398	45.00	23.380
Data & Probability	63.71	20.268	39.27	22.637	66.42	17.266	39.90	19.921	63.33	20.981	38.56	20.963
Geometry	63.37	17.596	41.28	22.115	64.99	19.244	37.84	20.526	68.49	14.590	48.89	19.685
Math Total Raw Score	356.70	81.372	220.18	97.695	357.59	84.151	200.62	81.571	367.63	78.515	240.00	88.989
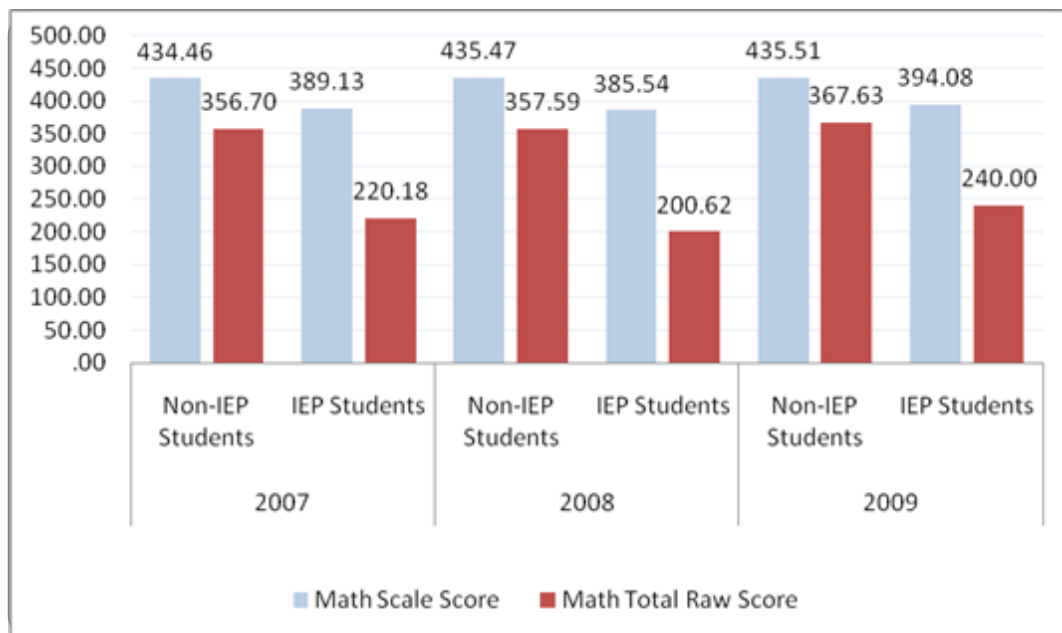
Figure 2. Comparison of IEP and non-IEP population for Math scale and total math scores

The t-test results for Non-IEP and IEP population are summarized below:

a) There was a significant difference between years 2007 and 2009, $t(1091) = -2.259$, $p < .05$, with 2009 mathematics total raw score for the Non-IEP students being higher than 2007.

b) There was a significant difference between years 2008 and 2009, $t(1058) = -2.013$, $p < .05$, with 2009 mathematics total raw score for the Non-IEP students being higher than 2008.

c) There was a significant difference between years 2008 and 2009, $t(185) = -2.060$, $p < .05$, with 2009 mathematics scale score for the students with IEPs being higher than 2008.

d) There was a significant difference between years 2008 and 2009, $t(180) = -3.147$, $p < .05$, with 2009 mathematics total raw score for the students with IEPs being higher than 2008.

According to a) and b), Non-IEP students' mathematics total raw score shows statistically significant improvement in 2009. Findings summarized in c) and d) indicate that students with IEPs' mathematics scale score and total raw score show statistically significant increase in 2009 compared to 2008. Both students with and without IEPs had to learn new instructional technology, MLDs, in 2008. Students both with and without IEPs performance did not show a significant increase from 2007 to 2008, and it is possibly due to their slow learning pace compared to Non-IEP students. In other words, it is possible that students with IEPs took longer time to get familiar with and adopt MLDs into their learning style, compared to Non-IEP students. Fortunately, their scores in 2009 show significant improvement.

DISCUSSION

The findings of this study suggest that MLDs are showing some positive effects on mathematics instruction for all students, including those with IEPs. Students with IEPs show an increased math score in 2009 versus 2007 when they did not use MLDs in the learning environment. While the students without IEPs showed a slightly higher total math score in year two, the total math score did increase from the start year. The increase appears to indicate that the teaching with MLDs is an effective tool for increasing students' mathematical knowledge. In addition, comparison data between students with IEPSs and non-IEP students' performance in each mathematics content standard informs mathematics teachers in various aspects: students with IEPs need more help with algebra and number and operations; or geometry are the areas IEP students can enhance their understanding the most.

Future implications include extending the use of MLDs to other districts in other states and providing well structured teacher training on how to use MLDs and how to develop effective activities for MLDs. To accomplish this, targeted professional development is needed to create comprehensive teaching modules. The content in the MLDs should be what draws in and motivates the student, rather than the device itself. Given students already have a great understanding of the device, teachers can continue positively facilitate student engagement in a way that increases content knowledge and readiness for STEM careers. It is the hope that with this added dimension, student achievement scores will increase and overall academic success will accelerate with curriculum goals being met for all students.

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Examining Usability in English Language Mobile Learning Materials for Technical Students

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ABSTRACT

Mobile computing technology enables accessibility of internet and the content of world wide web on mobile devices such as mobile phones. Inevitably, this triggers massive opportunities for learning. Almost all learning disciplines benefit from this technology and language learning is no exception. Nonetheless, language learning has its own properties that need to be adhered to. The four skills in language learning which are reading, listening, writing and speaking might not be equally emphasized when delivered through mobile devices. Content may be impeded by mobile features such as small screen and limited download capacity. This in turn could frustrate learners and retard understanding of learning points. Hence, the objective of this paper is to examine learners' response towards mobile learning through usability analysis. Using English for Technical Purposes as the subject, the research was conducted on forty-three students pursuing technical courses in four polytechnics in Malaysia. Students were asked to access the materials designed using their mobile phones of various brands. In order for them to be able to access the materials, they are required to have an internet-able phone. Internet connection was made using the technology available on their mobile phone. Hence, some mobile phones required only GPRS whilst others utilized the wi-fi services available at the learning premises. After testing the materials, students answered twenty-eight usability items. The summary of items statistics showed that the means of the items are at 5.640 and Cronbach's coefficient alpha reliability statistics stood at .984 . This showed that the items used were reliable. The results of this study further instigate the production of a much more comprehensive English language learning materials.

Author Keywords

mobile learning, usability , technical usability and   English language learning

INTRODUCTION

The delivery of learning package through digital media is often tangled in the issue of subject matter expert's intentions and designers' or programmers' ability to translate those intentions into meaningful learning materials. When the designers could not understand the intentions of the SME, the issue of usability may occur. Usability often refers to the ease of use and learnability of a product or object. According to Keinonen (1998) usability embeds the characteristics that relate to the product design process, the product itself, use of the product, user experience and user expectations.

The issue of usability is the concern of all types of products which are used by vast majority of people. Hence, electronic items such as photocopiers, video cameras, microwaves, mobile phones and computers lend themselves readily to the issue of usability. A product is normally designed to ensure that users can accomplish tasks using the items at minimum hassle. After all, most of the products were designed to aid users in accomplishing complicated tasks without requiring too much re-skilling. As mentioned by Adler & Winograd (1992),

> *..new technologies will be more effective when designed to augment rather than to replace the skills of the users. The key challenge in designing new technologies is how best to take advantage of users' skills in creating the most effective and productive working environment. We call this the usability challenge.(p. 3)*

Hence, in designing a product the development team shall consider the skills that users already possess and try to include the features that users need in order to accomplish a particular tasks and present those features in such a way that users can grasp easily and find efficient to use in the long term.(Wilkund,1994, Zaharias,2004). Take for instance the introduction of word processors in the early eighties. Word processors capitalize on users' skill in typing. But, today's word processing software includes instruction buttons that makes the writing process easier and almost effortless. There are buttons or icons that could type and retype, erase words, change font, insert tables and so on. This makes word processing software very

usable. Aptly, Wilkund (1994) defines usability as a design philosophy that places users' needs high-if not first- on the list of design priorities. Thus, usability analysis is important as it provides an insight into how users view the product or object.

In web-design for instance, Nielsen (2000) claims that usability rules the web. According to Nielsen, if a customer can not find a product, then she or he will not buy it. Usability has a vital place in the net-economy which might not be the case in traditional marketing. For instance, in the traditional market, customers do not have the chance to use the product before purchasing it. For instance, if someone bought a video camera and later on discovered that the procedure of recording was rather tedious then there is nothing much that the customer could do except to deal with the difficulty. A lost on the customer's part as the product is not user-friendly but the manufacturer still manages to sell the product. However, this is not the case with the software market. The software market is more aware of usability issues. Softwares were designed to be user-friendly and usable. This is translated by providing call centres or support systems to address users' difficulties or queries about their software. Furthermore, as Zaharias (2004) pointed out, users of software could return time and again and gradually learn the interface. This is not the case with instructional interface on the web. Consequently, in web-marketing, the issue of usability is pursued more aggressively. Users experience usability first before purchasing anything. When usability or user friendly products equates with profit then usability becomes a challenge that manufacturers have to address. Nielsen (1993) proposed five usability components which are :

1. learnability
2. efficiency
3. memorability
4. errors and
5. satisfaction

Learnability deals with how easy it is for users to accomplish basic tasks on first try of the product. Efficiency relates to how quickly users can perform the tasks once they have learned how to use the product. Memorability refers to how easy can users reestablish their proficiency after not using the product for a period of time. Errors refer to the number of errors, the recovery from errors and the severeness of those errors should users perform those errors. Satisfaction answers the question of how pleasant it is to use the product.

Preece et al (2007) is believed to have taken the idea and further developed the components into 'goals'. Trusting that usability is generally regarded as ensuring that interactive products are easy to learn, effective to use and enjoyable from the users' perspective,   Preece   added another three goals for usability which are:

- effective to use (effectiveness)
- safe to use (safety)
- having good utility (utility)

In the area of effectiveness, Preece et al (2007) considers effectiveness of a product to be how good a product is at doing what it is designed to do. Preece et al (2007) has also included safety as one of the usability goals. Safety involves the protection that users need from hazardous products such as products with high-radiation. It must also involves the feeling of being in control when dealing with hazardous products. For instance, users must have the ability to control the interface of the product to ascertain that they are not   exposing themselves to dangerous situation. As far as using the net is concerned, the dialog box or pop-up row allows the user to reconsider his/her intentions. This, indirectly, reduces the risk of performing an action unintentionally.

Utility, on the other hand, refers to the functionality of the product. Does the product provide the right kind of functionality to enable users to do what they want to do? An example of a product with poor utility is a banking website with no ability to transfer money from one account to another.

In a nutshell, the goals of effectiveness, safety and utility coupled with Nielsen (1993) five components of learnability , efficiency, memorability, errors and satisfaction touches the physical aspect of usability.

If all the components or goals are met, will the users feel satisfied in using the products? Preece et al (2007) suggested that apart from the physical aspect of the products that usability normally addresses, there is another criterion that one should look   into   and   that   is   user   experience.   User   experience   deals   with   subjective   aspects   such   as 'satisfying',   'enjoyable',   'engaging',   'pleasurable',   'aesthetically   pleasing',   'supportive   of creativity','motivating','fun','provocative','helpful','cognitively   stimulating',   'enhancing sociability', 'challenging' 'emotionally fulfilling' and 'exciting'. In short, the aspects mentioned answer the question of users experience in using the product.

As pointed by Preece (2007), user experience relates to how a product behaves and is used by people in the real world. Garrett (2003) stressed that every product that is used by someone has a user experience. User experience is about how users feel about the product when looking at it, holding it, using it, opening it or closing it. Take mobile phones for instance. Some mobile phones are designed to fit the palm, put in a pocket, open with one hand, texting with the thumb and so on.

Users who are looking for a small hand-phone, slick and handy will probably feel satisfied and at ease with the product. If mobile phones are designed to be bulky and difficult to operate then those mobile phones might not score highly on the user experience score sheet.

User experience may not be pleasant at all times. A research conducted by Jakob Nielsen (2009) examined the usability of websites displayed on mobile phones. Nielsen used three usability methods:diary study,user testing and cross-platform review. In the diary study, fourteen international students participated and they were asked to log everything they did using their mobile devices. In user testing, thirty three participants from the US and 15 participants from the UK were selected. They were given tasks that require them to log on to the internet using their mobile phones in order to get information. Finally, in the cross-platform review, twenty websites were reviewed on their designs.

The results of the study were not encouraging. They reported a success rate of viewing websites as of normal computer screen to be a mere 59% which is far from the success rate of 80% when testing websites using regular computers. However, when users use sites which were designed specifically for mobile users, the success rate increased to 64%.

There are many factors that influence user experience in usability analysis. Nielsen (2009) , Bertini (2005), Uther (2002) point to the small screen factor as a potential deterrent. They also agree of the limited input. Nielsen (2009) discussed the lack of a mouse might result in typo-errors thus delay information gathering. Another crucial factor is download delays. Because of limited capacity of mobile phones, downloading can be slow. This frustrates users especially when they need to download graphics and multimedia texts.

Nielsen (2009) further concluded that designing websites for mobile is difficult. He emphasized on the clash between making content and navigation of content salient and designing for a small screen and slow downloads.

In relation to designing for learning content, Nielsen (2009) study has alerted mobile designers and subject matter experts that it might be best to design specifically for mobile screen. In other words, considerations should be made to consider the special features and limitations of mobile phones if mobile learning is meant to be a success. Even with those considerations, there is no guarantee that user experience will be a favorable one.

In conclusion, it is inevitable for usability to be evaluated. Content developers as well as mobile designers need to understand what works and what do not with delivering content through mobile devices. There are many guidelines available. IBM provides an example on how to use questionnaire in evaluating technical usability. Ryu (2006) has also shed some lights on the issue of reliability and validity of mobile phone questionnaires. Lund (2001) also provides a useful insight on how this can be done. Cautioned with Lund's maxim in usability (Lund,1997), Lund (2001) came up with a set of constructs that can be used in evaluating usability. The constructs fall under four groups: usefulness, satisfaction, ease of use and ease of learning. The questionnaire is referred to as USE questionnaire. The items of this questionnaire are adapted to suit the purpose of this research.

METHODOLOGY

Prior to the research, a needs analysis was conducted on 373 polytechnic students. Out of the number, 57.6% were male and 42.4% were female. However, only 43 respondents were selected using the purposive sampling. Respondents, aged between 18 to 22 with an internet able phone volunteered for the study.

Since the purpose of this research is to examine the technical usability of the materials designed, a quantitative method is employed. The instrument used is a questionnaire which consists of twenty-eight items. The questionnaire was adapted from Lund's USE questionnaire and administered on forty three respondents from four polytechnics. The adaptation is mainly made to suit the mobile domain of the materials delivered.

The four polytechnics involved were as follows:

1. Politeknik Sultan Idris Shah, Sabak Bernam
2. Politeknik Merlimau, Melaka
3. Politeknik Sultan Mizan Zainal Abidin, Dungun
4. Politeknik Kuching, Sarawak

The respondents were asked to view a mobile site using the mobile phone. They were also requested to try out the materials on the site. After trying out all the components, the respondents were then asked to evaluate the usability of the site using the questionnaire given. The questionnaire used a 7-point Likerts scale.

RESULTS AND DISCUSSIONS
In order to determine the reliability of the questions set, the items are analyzed using Cronbach coefficient alpha (Cronbach, 1951). Netemeyer, Bearden and Sharma (2003) agreed that an acceptable level of adequacy for coefficient alpha has been at least 0.70. The question items were analyzed using Statistical Package for Social Sciences (SPSS). The value of Cronbach

Alpha for all the items was 0.98. Table 1 shows the coefficient alpha values for each of the four categories. All values of coefficient alpha exceeds 0.90

Category	Number of Items	Coefficient alpha
Usefulness	7	0.962
Ease of Use	10	0.968
Ease of Learning	4	0.947
Satisfaction	7	0.936
	28	0.984

Table 1: Coefficient alpha value for each category.

After determining the reliability level of the question items, the items are then analyzed to obtain the means. Means allow us to look at the overall perception of the respondents. The first analysis addresses the respondents' opinion on the usefulness of the mobile learning materials. The means range from 5.58 to 5.76. This shows that on the criteria of usefulness, respondents agree that learning materials presented using mobile phones are well received hence the materials are viewed as useful. Generally, they feel that mobile learning materials were useful.

	Usefulness	Mean	Std Deviation
1	It helps me learn more effectively	5.62	1.30
2	It helps me be more productive	5.58	1.48
3	It is useful	5.60	1.54
4	It gives me more control over my language learning activities.	5.58	1.34
5	It makes language learning easier.	5.65	1.44
6	It saves me time when I use it.	5.76	1.61
7	It is useful for my learning.	5.76	1.34

Table 2: Means and Standard Deviations of the Items on Usefulness

The second analysis reports on the respondents' opinion on the ease of use of the materials presented using mobile phone. Similar to the first analysis, the results shows that the respondents find that the materials presented using mobile phones are easy to use. The mean is reported to range from 5.34 and 5.81.

	Ease of Use	Mean	Std Deviation
1	It is easy to use the materials presented on mobile phone	5.67	1.49
2	It is simple to use the materials presented on mobile phone	5.69	1.48
3	It is user-friendly.	5.65	1.51
4	Using it is effortless.	5.62	1.54
5	I can use it without written instructions.	5.67	1.68
6	I don't notice any inconsistencies as I use it.	5.34	1.44
7	Both occasional and regular users would like it	5.74	1.48
8	I can recover from mistakes quickly and easily	5.55	1.57
9	I can use it successfully every time	5.39	1.63
10	It is flexible	5.81	1.46

Table 3: Means and Standard Deviation for the Items on Ease of Use

The third analysis addresses the respondents' opinion on the matter of ease of learning. With the items mean range from 5.44 to 5.65, the results show that the respondents feel that it is easy to learn to use the materials presented on mobile phones.

	Ease of Learning	Mean	Std Deviation
1	I learned to use it quickly	5.62	1.54
2	I easily remember how to use it	5.44	1.66
3	It is easy to learn to use it	5.65	1.47
4	I quickly became skilful with it.	5.39	1.51

Table 4: Means and Standard Deviation for the Items on Ease of Learning.

The forth analysis addresses the respondents' opinion on satisfaction when using materials delivered through mobile phones. The minimum mean stands at 5.62 and the maximum is 6.06. This shows that the respondents are satisfied with the mobile materials delivered through mobile phones.

	Satisfaction	Mean	Std Deviation
1	It is fun to use	5.67	1.52
2	I would recommend it to a friend	5.58	1.59
3	I am satisfied with it	5.62	1.63
4	It works the way I want it to work	5.62	1.44
5	It is wonderful	5.67	1.58
6	I feel I need to have it	5.76	1.34
7	It is pleasant to use	6.06	1.16

Table 5: Means and Standard Deviation for the Items on Satisfaction.

The results of the survey show that the respondents respond favourably towards language learning through mobile devices. The respondents feel that the method is useful, easy to learn, easy to use and in general they are satisfied with the materials and method presented. Thus, this could reflect Nielsen (1990) statement in saying that usability refers to how well the users are able to use the function offered by the system. Indirectly, it can be concluded that since all items bear the mean of 5 and above in all sections of the USE questionnaire, the English language materials delivered through mobile phones are usable by the population that the respondents represent.

CONCLUSIONS

As mobile learning is still in its infancy stage in Malaysia, data gathered could not be compared with any other studies in the same field as to date none has been conducted. However, the encouraging results promote a better understanding of how Malaysian polytechnic students respond to learning through new technology.

Since the response towards mobile learning materials is favourable, a number of possible researches can be conducted. The next probable research is to develop a much more comprehensive mobile learning module that includes short and long reading texts, listening materials that comprise both the local and native speakers' voices and perhaps should also include games and video clips. Other areas can also be researched, for instance analysing the inclusion of podcasting materials in mobile learning materials. Short assessment texts that include objective questions could also provide another domain that could be researched.

In short, by accepting mobile phones as not only a tool for communication but also a tool for learning, teachers have the liberty of designing and experiment with the possibilities that mobile learning could offer. Hopefully, this could enhance teaching and learning and help students in the mastery of knowledge.

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TOPIC 7: Adaptive, virtual or collaborative environments for mobile learning

Long Papers

A User Study of the Spatial and Temporal Dimensions of Context to Support Virtual Learning Environments

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ABSTRACT

This paper describes a user study of two RSS based information retrieval widgets to support mobile learning within a higher education environment. Created and deployed for implementation on a GPS enabled Nokia devices, the user is presented with arbitrary information from the virtual learning environment based upon either their schedule or location. The study aims to identify whether integrating location context awareness can override the utility of temporal based mobile electronic alerts. The major function of both the mobile applications is to disseminate information surrounding course updates and deliver these in a context of either time or space, aiming to identify if there is precedence between these two dimensions of context. Results from both quantitative and qualitative data indicate that both applications were evenly helpful for receiving information and supported the way in which the students organized their learning. The other outcome of interest was that both the space and time applications were deemed equally unobtrusive in their personal space, although utilizing location information was deemed a less comfortable form of ambient information.

Author Keywords

Mobile Learning, Virtual Learning Environments, Location Based Services, Information Retrieval, Context Awareness

INTRODUCTION

The abundance and availability of wireless mobile devices has created the requirement for information retrieval to grow at the same rapid pace. Simultaneously, mobile applications and widgets have exploded in popularity and provided users with the ability to receive updates for information such as news, shopping, and social media or email updates. These automatically executing services are mostly defined and instructed to do so by time or by a frequency of time. Although these are effective they do have issues such as those discovered in the previous studies by Crane et al (2010). Yet, with the integration of GPS functionality in most smart phones, context dimensions such as location can now be used as update points, mostly known as location based services. It is the concepts of temporal and spatial dimensions, therefore schedule based services and location based services which are deemed the two fundamental points for context aware applications (Smailagic et al, 2001). Integration of location based services into mobile applications has given proliferation to a range of application fields such as shopping, advertising, travel information and entertainment. Although location based services have been utilized successfully for many domains, their use in the organisation of learning has remained primitive. One clear example of how location based services can be included to support flexible learning is given by Sohn et al (2005) where reminders were created and deployed on a specific location rather than at a specific defined time of the day. Yet this service unexpectedly discovered the points of reminders were often used for creating motivational reminders of the individual's priorities. The relationship between time and location is of interest to this project, as to provide a ubiquitous learning environment understanding the context of the user must be of paramount importance for information retrieval and delivery. Although temporal updates are the standard for most information retrieval, using locative aware technologies to automate updates may offer an alternative to the regular temporal system. Rather than a constant stream of information channeled through to the device based upon time, which itself is a measurement which cannot be personified, location which completely denotes the situation may offer an alternative.

Previous research was undertaken to identify student's trends and attitudes towards both accessing the virtual learning environment and also their mobile device activities (Crane et al, 2010). This study showed student access to the virtual learning environment majorly remained by laptop or netbook, with few accessing it via mobile devices. User trials for a temporal based information retrieval mobile widget have shown that user engagement can be sustained when a motivational design framework is integrated with mobile information delivery. The study used the ARCS model (Keller, 1979) of motivational design and instruction theory (attention, relevance, confidence, satisfaction) as a tool to enhance

student learning experiences and subject engagement using a mobile widget for RSS applications. A further study comparing RSS and Twitter, as delivery mechanisms based on the same theory of motivational design and instruction, was also implemented and presented in by Crane et al (2011). User feedback from these studies revealed the following conclusions: although users were given flexibility with regards temporal updates where they could choose how often they would like daily notification, feedback confirmed that all participants preferred temporal updates at specific times (once a day preferably at the end of the day) and not in real time. Secondly, the network coverage on campus which was designed to support nomadic computer use not necessarily mobile phones, where the wireless LAN network is limited to buildings. This also conveys a lack of wireless access around the open areas which are used for communal use by the students, as well as the on campus accommodation and therefore a major area which students use as part of their routes on campus. Subsequently this paper aims to investigate if locative aware services can provide an alternative solution compared with a purely temporal service. Research on spatial dimensions (user locations) is being explored to gain insights into location-based electronic alerts. Further, an understanding of the benefits and limitations of the different context dimension (spatial and temporal) will enable application designers to utilize context fully to engage end users in their applications. The paper explores also the order of precedence when using contextual dimension for mobile information delivery in order to understand students' reaction and experiences when using these differing contexts.

The paper is organized as follows: Section 2 describes and discusses the rational for context aware mobile virtual learning environments and how dimensions of context can be used to support mobile learners by automatically adapting the contents to the individual's current context. Based on previous research in the field of context-awareness, it is argued that similar solutions can be constructed for virtual learning environments to provide a dynamic solution for learners. Section 3 details the study and technology used to implement the spatial and temporal dimensions of context for supporting students and virtual learning environments; it also covers the challenges presented with respect to network coverage and the framework used for assessing user feedback. In Section 4, the responses to the quantitative and qualitative feedback are evaluated with particular focus on four key points: intrusion into student's domain, support for the student's organization of learning, perceived helpfulness for receiving course information and user contentment (satisfaction) when using student's ambient information. Section 5 addresses the order of precedence of context dimensions, and the understanding of context-awareness to be beyond location. In this section, a preliminary study is carried out which observed the order of precedence when interviewing cohorts of students in three different contexts: a lecture theatre, a learning zone and student accommodation. Finally, discussion and concluding remarks are presented in Section 6.

CONTEXT AWARE MOBILE VIRTUAL LEARNING ENVIRONMENTS

Previous studies (Figure 1) have been conducted to establish the methods of access of students when using the virtual learning environment, this conveyed a large proportion of students still relied upon both wired and wireless network access. Only a slight amount of the 122 respondents accessed the virtual learning environment by a mobile device; many citing the lack of adaptability with mobile browsers, subsequently defeating the usability of the virtual learning environment on a mobile platform. Yet, with the majority of respondents stating they use the virtual learning environment on a daily basis, it can be argued that mobile access is now the natural advancement to maintain the support it already provides for the students. Mobilization derives new challenges and opportunities to heighten the experiences which can be provided by educational institutions for the new generation of digitally native and naturally mobile students.
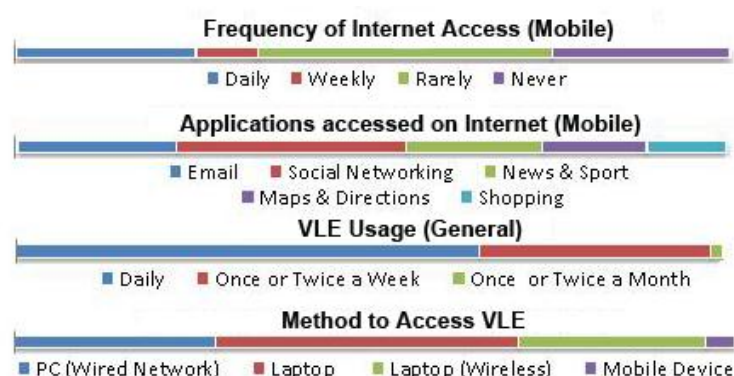
Figure 1. Previous research into use and access of VLE

With the most advanced virtual learning environments providing a well demonstrated and recognized system for supporting and organising learning, their place in modern education is now well identified. They are mostly inherited desktop based systems, and still provide appropriate augmented provision for traditional face to face learning. But with the prominence and prevalence of mobile devices as primary information access tools; virtual learning environments require portability of the significant information which is readily available. Creating functionalities which discover and denote

'online presence' within virtual learning environments have discovered students responded well when they feel a sense of personalized presence within that community (Anetta & Holmes, 2006). But with online presence only being one possibility which utilizes a meek form of context to engage students, the possibilities for context integration are far more excessive.

Contemporary mobile communications now create the possibility for ubiquitous learning environments. Previously, computer assisted learning relied on desktop 'tethered' systems which by their very nature prevented the prevalent availability of information (Traxler, 2005). In comparison, mobile learning ultimately aims to increase learners' capability to move within their own environment and between differing contexts. As a term mobile learning encompasses any device which '..any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies' (Taylor et al, 2006). These devices can be utilized to fill the void which exists between web based and ubiquitous learning, creating a seamless environment for which learning can transpire. Mobile devices can connect to the web with wireless communication technologies and therefore enable learning at anytime and anywhere. Subsequently, this requires migration from learning which used to be delivered "just-in-case," can now be delivered "just-in-time, just enough, and just-for-me" (Traxler, 2010).

Unfortunately, navigation of large virtual learning environments sites using iterative, task specific elemental queries is primitive and in fact not mobile device friendly as previously stated by Yee et al (2009). With the need for more personalized, timely and concise information now a pre-requisite for mobile learning environments, investigating how we can use current advances in technology to deliver this information is important for engaging users with these new systems. An example of this is context-awareness. Context-awareness is the field of computer science which relates to '..*any information that can be used to characterize the situation of an entity*' (Dey, 2001). Of course, in order to use context itself, the definition of its associated dimensions must be understood; five categories of context have been specified; these being time, location, identity, activity and relationships to other entities and objects (Zimmerman et al, 2007). Although there are five possibilities for context-aware applications the most obvious and widely adapted are that of time and location. The overall objective of this field is to use the ambient information which exists in any given situation or context effectively to deliver an optimized service to the user. The three branches of services states are that of presentation of information and services to a user, automatic execution of a service for a user; and finally tagging of context to information for later retrieval (Dey, 2001). All three of these parts could be utilized in virtual learning environments in order to deliver information to the user, execute services automatically based or tag their time or position for future reference or learning activity. Previous projects such as 'eBag' successfully demonstrate using context awareness by supporting and engaging nomadic learning using location as the primary dimension by Bluetooth enabled mobile device (Brodersen et al, 2005).

Providing context-awareness into mobile virtual learning environments can be an efficient method of refining the usability of mobile virtual learning environment access and services by automatically adapting the contents to the individual's current context. Although other dimensions of context could be utilized, the most obvious and feasible to implement is that of location. The abundance and availability of wireless mobile devices has created the requirement for information retrieval to grow at the same rapid pace. Simultaneously, mobile applications and widgets have exploded in popularity and provided users with the ability to receive updates for information such as news, shopping, and social media or email updates. These automatically executing services are mostly defined and instructed to do so by time or by a frequency of time. Although these are effective they do have issues such as those discovered in the previous studies by Crane et al (2010). Yet, with the integration of GPS functionality in most smart phones, context dimensions such as location can now be used as update points, mostly known as location based services. It is the concepts of temporal and spatial dimensions, therefore schedule based services and location based services which are deemed the two fundamental points for context aware applications (Smailagic et al, 2001). Integration of location based services into mobile applications has given proliferation to a range of application fields such as shopping, advertising, travel information and entertainment. Although location based services have been utilized successfully for many domains, their use in the organisation of learning has remained primitive. One clear example of how location based services can be included to support flexible learning is given by Sohn et al (2005) where reminders were created and deployed on a specific location rather than at a specific defined time of the day.   Yet this service unexpectedly discovered the points of reminders were often used for creating motivational reminders of the individual's priorities. The relationship between time and location is of interest to this project, as to provide a ubiquitous learning environment understanding the context of the user must be of paramount importance for information retrieval and delivery.   Although temporal updates are the standard for most information retrieval, using locative aware technologies to automate updates may offer an alternative to the regular temporal system. Rather than a constant stream of information channeled through to the device based upon time, which itself is a measurement which cannot be personified, location which completely denotes the situation may offer an alternative.

DESCRIPTION OF THE STUDY: SPATIAL AND TEMPORAL DIMENSIONS

In order to test both spatial and temporal dimensions of context for supporting students and virtual learning environments; two new mobile applications were designed, constructed and deployed using Nokia's Web RunTime frameworks, the first using location information coupled with contextual information to deliver relevant RSS updates, and the second using purely temporal information. Both these mobile applications will be constructed using a compound of HTML, CSS, JavaScript and XML technologies to download and present the user with information which ultimately supports their learning experience. The temporal mobile application was a simple RSS mechanism which disseminated virtual learning environment electronic alerts for a defined frequency of times per day, according to the user's preferences. The spatial application centered on receiving the user's position by the integrated GPS option within the phone itself. Once the coordinates were received, these were input into the adaption engine of the application; in which the user's location was correlated with the nearest news source. The concept was to provide course updates from the virtual learning environment as well as the option of personalized content for their geographic location within the campus site.
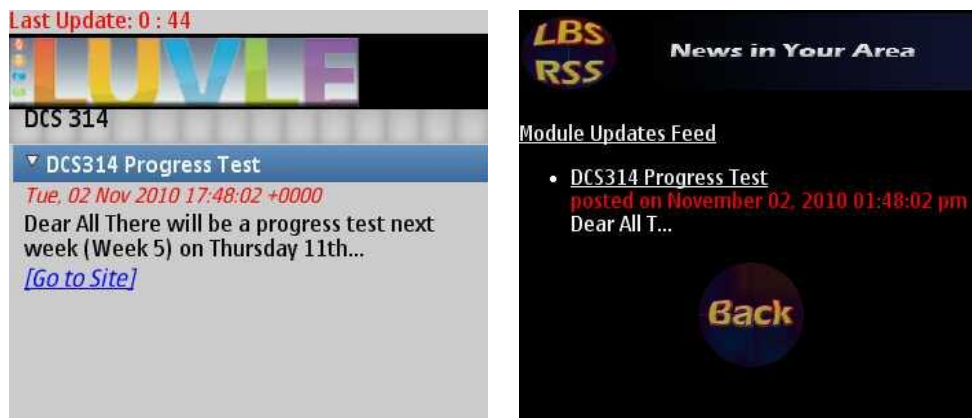
Figure 2. Screen view of the two applications

Figure 3. Demonstrates the overall principle to the location based (spatial) adaptive campus information service.

Rather than relying upon the nomadic free wireless access to provide connectivity to the mobile devices, pre-paid mobile network data cards were provided to alleviate the problems faced in previous studies in which users struggled to access

information. This meant the students were no longer bound by the inconsistent and unreliable network which plagued earlier projects. Both sets of students were selected randomly from a third year consumer technology module, with differing lives and circumstances. When the field study was implemented, a participant survey was completed by all the test-base; this is to provide quantitative feedback of the students experience with this assistive technology. The survey consists of statements for which the student's responses was measured by a limited scale, such as the five-point Likert scale. Subsequently, the differences between firstly, the students attitudes after their experience with mobile information updates and secondly, the differences between location and time based virtual learning environments aggregators. From here, random sampling was used to assign the participants into two separate, but equal groups; one set for the location widget and one set for the time based widget. The other form of feedback generated was of a qualitative nature, with the responses from an in-depth interview with the participants after the study was completed. This qualitative study aimed to gain more of an insight into how they found dealing with their context-aware applications on a more operational basis.

QUANTITATIVE RESPONSES FROM LOCATION AND TEMPORAL BASED UPDATES STUDY

Four key points were focused upon during the results stage of the study, these were of the highest interest to the project, and were posed to students during both quantitative and qualitative points of the feedback exercises. These were: intrusion into student's domain, support for the student's organization of learning, perceived helpfulness for receiving course information and contentment when using student's ambient information. These points were deemed the most important in measuring if locative information retrieval can overcome the challenges which were faced by the typical time based information systems. Once the study had ended, the students were asked to complete a feedback form individually to provide a measured response to their experience. This survey included the four key points, (denoted in Figure 3) amongst other questions, and the results of which can be seen in Figure 4. The key points which can be deduced from the graph were that both sets of the students considered the mobile applications equally unobtrusive within their own domains. Although time was deemed a slightly more comfortable utilization of ambient information. Furthermore, both sets of user sets valued the application identically for supporting the organization of their learning and helpful for receiving course information. Again, a positive outcome for the study can be argued with both sets of users responding positively to using mobile virtual learning environments in the future.

Figure 4. Quantitive Responses from Study

After the six month period which spanned two taught modules, the students were interviewed in depth about their experiences. The results feedback was recorded by an audio recorder, but their experiences were summarized in the following table:

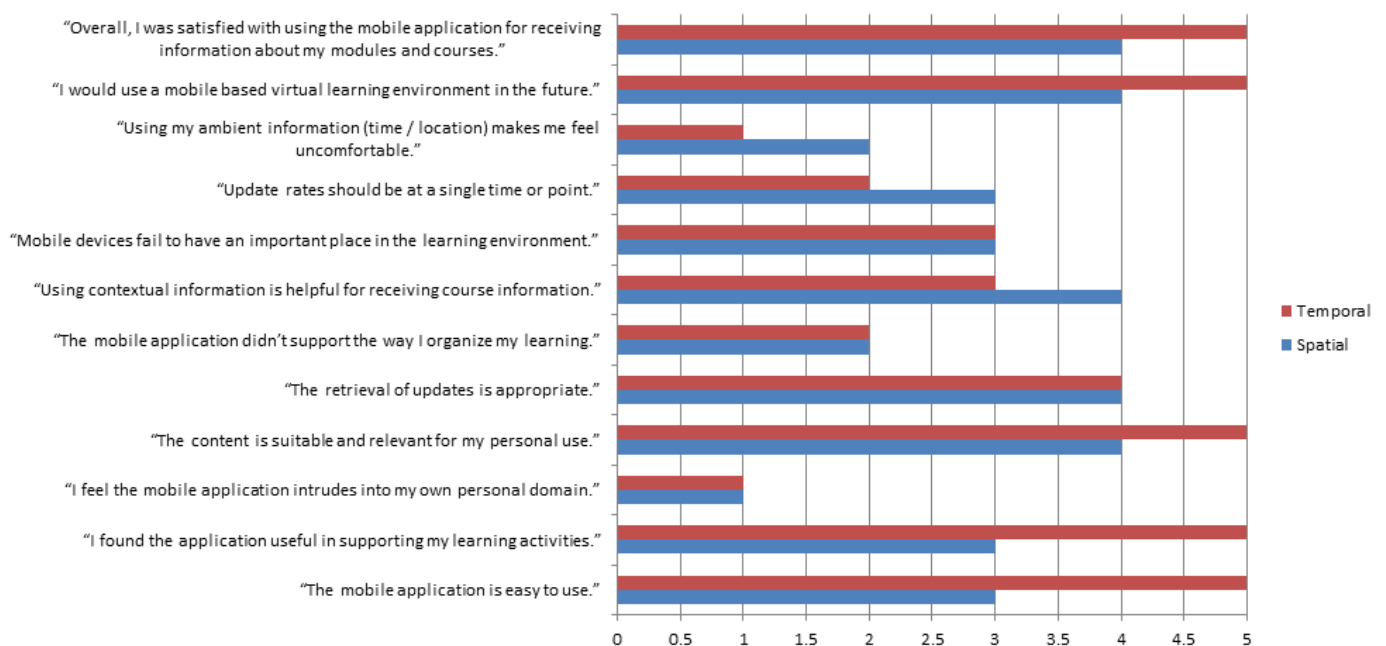| Point of Interest	Temporal Response	Spatial Response
Intrusion into students domain.	"No, unless the movements are collated and recorded for an alternative purpose."	"No, unless the movements are recorded for other purposes. Always the option of simply ignoring the message or turning off phone."
Support for the students organisation of learning.	"It did, but not schedule and routine changes on a daily basis, therefore the application must also understand this."	" I generally do the same routes around campus, and visits the same places on a daily basis."
Perceived helpfulness for receiving course information.	"Still have to make a conscious decision to read the updates. May be useful, but overall the individual has the choice to read them or not."	"Yes, but 'Exit Checkpoints' on campus, when you hit a checkpoint it could update before you go home."
Contentment (Satisfaction) when using students ambient information.	"No – not at all. Only those who have something to hide."	"Level of interest, depends on usage by those who are running the systems. If this was the case I would be concerned."

Table 1. Responses of the four users surrounding their experiences

Both interviewees agreed that they didn't object or disapprove of the intrusion into their own domains, provided the information was safe, secure and not used for alternative purposes. Location did override the issue of time being a changing variable on a day to day basis, as patterns of loci do not change to the same degree. The notion of exit checkpoints for the campus environment was raised by the location user arguing an automatic update when arriving or leaving the campus environment would be extremely useful for supporting her learning.

PRECEDENCE OF CONTEXT DIMENSIONS

Understanding context-awareness to be beyond location is again important in understanding the possibilities available for delivering information in context. Since Barwise (1987) aimed to describe situations over three decades ago, the importance of other contextual aspects such as the individual and the relationships to other objects were understood. More recent work (Schmidt et al, 1999) investigated and promoted the idea of context being more multi-faceted than that of location awareness. The most recognized model for context dimension is that of a pentagonal form consisting of time, location, activity, identity and relationships (Dey,2001; Zimmerman et al,2007).
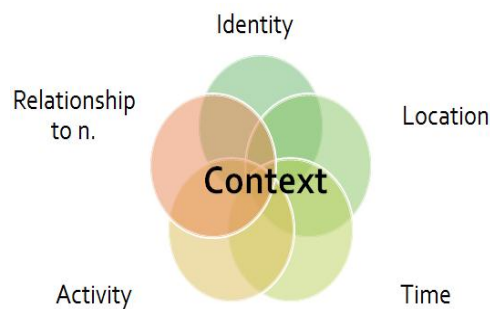
Figure 5. Dimensions of Context

Although Dey (2001) argues that "*We cannot enumerate which aspects of all situations are important, as this will change from situation to situation*" understanding if it is possible to arrange the dimensions of time and space, amongst others,   in an order of importance became of interest to answering the original research query. Defining a list of preference or precedence for delivering information from a virtual learning environment to a mobile device became of relevance to this study as it allowed an insight into the importance of time and location in direct relation to other and less obvious dimensions of context. A preliminary study was carried out which observed the order of precedence when interviewing cohorts of students in three different contexts. The students were asked to arrange the five dimensions of context in order of importance to themselves in their setting. One study was carried out in the morning within a lecture theatre, the second within a designated learning environment at midday and finally, the third within student accommodation during student's free-time in the evening. Although there were slight differences between the responses within the different context-situations; a general theme emerged from the results.

The results, which can be seen in Figure 6, demonstrate the distinct differences when the same question of importance between elements of context is asked in different contexts. Another noticeable point is the lack of interest or importance for

relationships to other people and objects in all three of the study exercises. The identity of the user was deemed more critical during the first two study settings, but becomes insignificant when the user is in their own time and domain. Further it emerges that time is placed as being more important than that of location consistently during this exercise. The aggregated outcome is that the order of precedence proceeds from firstly time, followed by activity, time, identity and finally relationships to other people and objects. From this preliminary insight into student's concepts of context, temporal information is deemed to possess the highest precedence amongst other possibilities. Of course this is a theoretical evaluation and therefore any conclusion must be formed upon implementing time and location based mobile virtual learning environment applications.
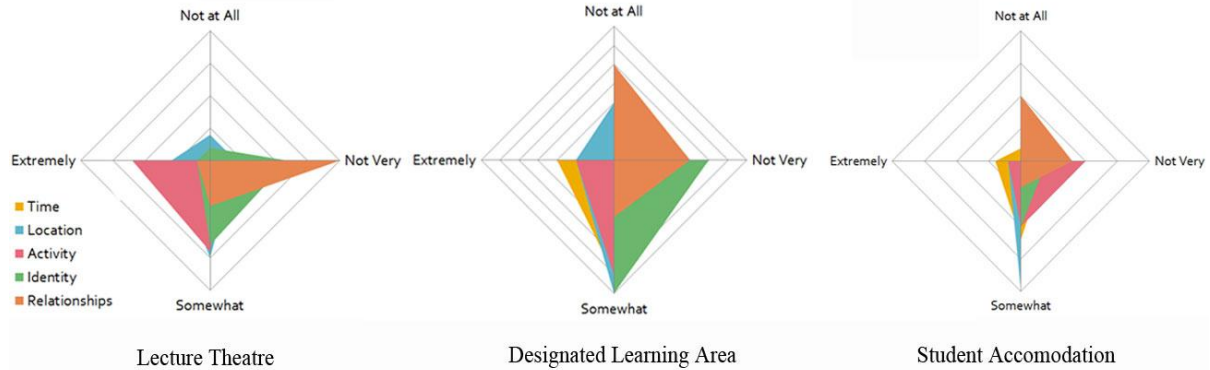
Figure 6. The three different sets of study results from the context precedence experiment

CONCLUSIONS & FUTURE DIRECTIONS

From the feedback received from the participants, location awareness does appear to be a feasible technology to be implemented into mobile virtual learning environments. Although the level of contentment of utilizing locative information does suggest a hindrance to a full immersion of context aware technology, a solution to this issue may involve including students within the design process so any inherent fears of privacy concerns may be eradicated. Although the investigation into precedence of context dimensions convey that temporal requirements were more imperative than that of location; the tangible deployment of both applications demonstrates how location can override purely temporal requirements. Further work can focus on investigating how the user can define the schedule or location updates themselves, rather than being defined by the applications functionality. The idea of 'exit checkpoints' or a 'buffer zone' for location based updates is an interesting area to explore which would be easily implemented in a campus learning environment. Again, creating an application which supports a wider range of contextual dimensions, such as activity and identity could also create an interesting insight for integration within future mobile virtual learning environments.

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GiftFinder: A Web 2.0 Recommendation System Using Mobile Technologies

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ABSTRACT

In today's hectic lifestyle it becomes a challenge to fit all of our errands into an acceptable amount of time. One major time-eater is shopping whereby we can spend hours looking round a massive shop to find just the right item for ourselves or to buy as a gift.

To reduce this lengthy time in shopping we look to recommendation systems to make our lives easier, however we do not want to spend time filling in profiles about ourselves as is required with most recommendation systems. We also want to be able to get recommendations for other people and not just ourselves.

GiftFinder aims to alleviate these problems by making use of a number of Web 2.0 technologies such as Social Networks, Wikis and Concepts. To provide users with recommendations for any of their friends on their mobile device by interfacing with a shop server and a backend database of products.

Author Keywords

Recommendation systems, conceptual maps, User interests.

INTRODUCTION

In this paper, we treat the subject of Recommendation System and Information Retrieval which is based on Web 2.0 technologies and Semantic Technologies. We consider the possibilities in real-time Mobile device processing such that users can get faster results when they need them the most. We also treat problem of collaboration on the Web and the Vocabulary Problem which causes issues when matching tags.

We aim to develop an application which takes into account the problems and technologies mentioned, and uses them to its advantage to provide accurate and reliable results.

Initial evaluation has proved that the final results are both accurate and correct and the system would benefit from further investigation into the correlation between initial information and the final results returned.

BACKGROUND

When considering all the information available on the Web, it makes sense to take advantage of this information to develop better, more efficient applications.

Web 2.0 technologies have made the information on the Web available to anyone wishing to make use of it responsibly and without infringing on anyone's privacy.

There is also a high use of recommender systems on the Web which we see on multiple shopping websites and on social networks however their capabilities are not limited to these domains only and we look into ways in which they can be applied to a wider domain.

Web 2.0

Web 2.0 refers to the technology whereby users are provided with tools to interact with the web in a slightly more intelligent way. Thus even non-technical users can achieve more (Young, 2008).

From the different Web 2.0 technologies available, we aim to put into practice, user-centered design, crowd-sourcing and collaboration while also using various APIs.

We look to social networks as a method of information retrieval taking care of privacy issues. To do this we would require an API (Fitzpatrick, 2007) to be able to create a useful application while respecting user privacy. We also would like to make use of Wiki's to retrieve more information based on the user's interests.

Recommender Systems

As we wish to be able to make recommendations to our users based on their interests, we take into consideration already established recommender systems and their strengths and weaknesses.

The two basic types of recommender systems are collaborative-based and content-based systems. Collaborative systems group users into similar stereotypes to assess what they would be interested in based on past purchases or information

provided directly (Peis et al.; Basu et al., 1998). The problem with collaborative systems is that new users or products do not get properly recommended because they have no information connected with them. Content Based systems generate recommendations by comparing user preferences with data representing products and do not take into account other users (Peis et al.; Farsani et al., 2006). These types of systems are unreliable, however, when little or no information about users or products are available (Basu et al., 1998). For the purpose of our system, we also consider Semantic Recommender systems where user profiles are used to represent long term interests of the user. However a weakness exists such that communication processes between the agents which gather information and users is not straightforward due to the different methods of data representations (Peis et al.)

We therefore find it interesting to attempt a hybrid between Content-based and Semantic recommendation systems.

Data Representation

In order to efficiently represent and manipulate the information retrieved we look into the theory of conceptual maps which represent concepts and relationships between them. Liu et al. (Liu et al., 2004) have made use of concept maps to find paths between concepts and determine the strength of each path.

We investigate methods of finding the paths between two concepts. Our research showed that tree-traversal algorithms in graphs are normally based on a Breadth-First Search (BFS) algorithm or a Depth-First Search (DFS) algorithm (Code Project, 2009). The selection depends on how we want to traverse the tree to find paths.

To find the strongest paths we must give the concepts in the tree weights and so we would require methods of calculating these weights. One such efficient method is TF-IDF (Manning et al., 2007). In TF-IDF, the importance of a word increases proportionally to the number of occurrences of a word in the document but is offset by the frequency of the words in the corpus.

The resulting data would also need to be sorted. Numerous sorting algorithms have been developed over the years, however our sorting algorithm would need to be able to handle large amounts of data and use minimal space on the cache. After conducting some research it was evident that the best option for our system is the merge sort algorithm (Lang et al., 2010). The system may also make use of a Thesaurus to offset the Vocabulary problem which may result in some results not matching due to the use of different words to represent the same thing.

User Interaction

In today's society, it is rare to find someone who does not own some sort of mobile device. Due to their portability and power, many organizations have dedicated large amounts of resources to developing applications on this technology but there is still potential in their real-time applications when connecting and sharing information with other devices. This is particularly relevant to GiftFinder as the front end can take advantage of such devices to deliver a more portable and lightweight experience to the user. Technologies such as Bluetooth and Internet allow applications such as GiftFinder to work on the go, thereby being able to integrate the experience with the routine that users are already accustomed to.

Summary

In conclusion to the background we have briefly presented, our system would mostly benefit from focus on generating correct results through the use of numerous Web 2.0 technologies and Semantic technologies such as Concept Maps. The use of Mobile Technologies would serve well as a means of sharing the information but would not contribute in any way to the system's intelligence and so may not be emphasised upon, depending on available resources.

The computation of the system to lead to the final results would consist of backend calculations and not require input from the users thus attempting to provide accurate results with virtually no user input.

DESIGN AND IMPLEMENTATION

We design GiftFinder based on the background provided making use of Social Networks, Concepts and Collaborations from Web 2.0 to result in high Information Retrieval without the need of a large amount of initial data. Through these technologies we develop a recommender system which is a hybrid between Content-based systems and Semantic recommender systems. Our recommender system uses a backend database to retrieve products to recommend to the user who has connected to the system using their Mobile Device.

Specification and Ideal System

We expect that GiftFinder should exhibit characteristics of correctness and relevance, portability, security, minimum user input and high performance.

The most important objective of GiftFinder is to return recommendations which are relevant, correct and meaningful. The results should be listed in order of relevance, first item in the list being the most relevant and the last item in the list being the least. For this reason the tags used to generate the list of results will be weighted from 0 to 1 with 1 meaning a very relevant tag and 0 meaning not-relevant. It is also expected that GiftFinder be a technology that the user would use when in a shop for example and so shall include the use of mobile technologies such as Internet and Bluetooth. Also as privacy issues are a major concern in today's society, only the user of the mobile device shall be aware of the 'friend' they are searching for a gift for as the server will only be given information about the friend's interests and will not have any access information for their social network profile page. The last two characteristics go hand in hand. As we do not want the user to spend any length of time longer than a normal shopping trip and ideally reduce this time, we would only gather the minimum information possible from the user and expect that the system produces recommendations within an acceptable time-frame.

In an ideal system, where resources are infinite, the system would make use of social networks to extract initial information about the person whom the user wishes to get recommendations for. From this information, wikis and a concept generator would be used as a knowledge-base to increase the concept map which would be used to extract recommendations from a backend database of products. The system would provide a client-server architecture where the mobile device of the user would connect to the shop's server via Bluetooth to send the social profile information and receive in return recommendations and tagsplanations9.

The system would also have an interface for the shop where the shop keeper may add products to the database and using wikis would attach tags to the product. The tags would then be used to get information such as concepts and similar words from a thesaurus to increase the relevant information in the database.

Entities

In order to understand the implementation of the system, some basic design structure must first be explained. In our system we make use of structures which we built ourselves to serve the purpose that was required of them.

One of the most crucial parts of the system design was that of the Graph structure which represents the Concept Map10 of interests for the user's friend. In the graph, each node represents a concept related to the user and there exists relationships between each connected node. We use the terms:

Parent refers to any node in the graph which points[11] to the current node which we are considering.
Root means an original node which was retrieved from the friend's profile information.
Child is any node which the current node points to.
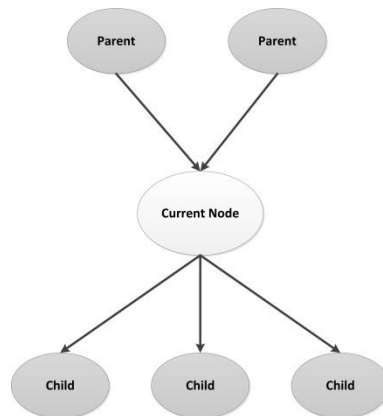
Figure 1- Typical Graph Structure

We set certain rules on our structure which are:
1. A graph can have many roots.

2. A graph shall only have 1 occurrence of any node.

3. A node can have multiple parents or children.

4. A node can point to the same child multiple times provided that it does so with different relationships.

To understand the structure of a node, the structure of a keyword must first be understood. A keyword structure represents a word which is related to the friend, a weight signifying the importance of the word and whether or not the keyword is original. A node structure therefore represents a keyword in the graph which has relationships with its parents and children.

Client-Side

The design of the client application on the mobile device involves the use of an Android OS on which we have chosen to base our system due to its close relationship to the development language used on the server side and its capabilities in supporting Bluetooth, and the facebook™ API.

On the client side the user is presented with a facebook™ window to log in to their profile and select a friend for whom they wish to get recommendations. Since facebook™ is a highly popular social network with many users and also has a mature and reliable API, this was selected for our prototype. The application would extract from the friend's profile information about their interests in music, television, books and movies and this would be sent via Bluetooth to the shop's server.

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[9] Explanations based on tags

[10] Map, Graph and Tree interchangeably to refer to the Concept Map built to represent the user's friend's interests.

[11] For a node to point to another node means that the former node has a relationship from it to the other node.

Since the system would cater for more than one user at a time, we also implemented a polling system whereby the mobile device would periodically 'ask' the server if it was ready to send it results, thereby not blocking the server's Bluetooth port while processing the request and hence allowing other device to make requests meanwhile.

Server-Side

The server-side application involves two processes. One part processes the client request and another part of the application processes the shop's request to add new products to the database.

The former part is the main part of our system which generates recommendations while the latter was simply implemented to show how the ideal system would generate tags for the products.

When processing the client's request, the server application would have a Bluetooth listener constantly waiting for new connection to send over profile information for processing. On receiving the information the server would reply to the client that the information has been received and is processing. Meanwhile the Bluetooth listener starts to wait for new requests again, replying to the client's polling when requested. The profile information is added to the Graph as original nodes and given a weight according to the total number of interests and their category as shown in Equation 1.

$$originalWeight = \frac{no.\,of\ interests\ in\ category}{total\ no.\,of\ interests}$$

Equation 1 - Calculating Original Word Weight

Each original node is then passed to a Google™ custom search engine in order to receive a Wikipedia™ page of information. This page is then parsed to extract only the links and the keywords in the first paragraph[12]. The keywords are stemmed and their TF-IDF value (Manning et al., 2007) is calculated (See Equation 2).

$$tf_{i,j} = \frac{n_{i,j}}{\sum_k n_{k,j}} \quad idf_i = \log\left(1 + \frac{|D|}{|j:\,t_i \in d_j|}\right)$$

$$(tf - idf)_{i,j} = tf_{i,j} \times idf_i$$

Equation 2 - Equations to calculate tf, idf and tf-idf

Their weight is then calculated by taking the weight of their parents and giving the keywords a weight relative to their parents and TF-IDF values (See Equation 3).

$$childWeight = parentWeight - \left((1 - parentWeight) * tfidf\right)$$

Equation 3 - Keyword Weight

Should the keyword already exist in the graph, then the weight is calculated according to the parents' weights but then the weight of the existing node in the tree is boosted according to the new weight (See Equation 4).

$$\boldsymbol{final}Weight = originalWeight + \left((1 - originalWeight) * \boldsymbol{newWeight}\right)$$

Equation 4 - Boosting a Node's Weight

The weights of the links are then calculated by taking an average of the weights of the keywords since links cannot be calculated using TF-IDF.

Following this step, for each keyword we use the ConceptNet API to retrieve related concepts to the keywords. The concepts are returned with a score and for each concept, it's ratio is calculated as a percentage of its score against the total of all the scores and its weight when being added to the tree is calculated as in Equations 3 and 4 (depending if the same node exists in the tree) replacing the TF-IDF value for the score percentage.

The next step in GiftFinder's processing is to trim the tree. This is done by only keeping those nodes which are on a path between original nodes or whose weight is above the average of the nodes on the important paths[13]. This is done to remove

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[12] We limit the search to the first paragraph only to prevent the graph from exploding and becoming too large. The first paragraph would normally be a summary of the rest of the page and have enough detail for the purpose of this system.

[13] Important paths are paths which connect original nodes

nodes which may be out of context or may interfere with the final results because they are not very relevant. The trimming is done using a Depth First Search algorithm (Code Project, 2009).

The weights are then matched with the products in the database to retrieve a list of weighted products to recommend to the user. These products are sorted using a Merge Sort algorithm (Lang et al., 2010) and the top ten results are returned to the user.

The latter part of the system, adding products to the database, uses similar APIs as the former. The Google™ custom search engine is used to retrieve a Wikipedia™ page and keywords are extracted from this page as explained earlier in this section. Each keyword is then passed to the ConceptNet API to retrieve related concepts and to the Thesaurus API to retrieve words with similar meaning in order to alleviate the Vocabulary Problem (See Section 2.3). The final list of tags is then added to the database with the product name.

EVALUATION AND RESULTS

Evaluation Background

GiftFinder has multiple aspects which can be evaluated; however we choose to evaluate the two most important parts of the system.

Firstly we look at how we can evaluate the recommendations. There exist multiple methods in evaluating recommendations such as the use of Precision and Recall, Rank Score and Lift Index (Jannach et al., 2009).

The second part of the system we shall be evaluating is the UI. Like the recommendations, there are multiple possible methods of evaluation, most significantly, Expert Evaluation which could be a Cognitive Walkthrough or Heuristic evaluation, a User Evaluation in the Lab or a User Evaluation in the Field (Nichols, 2010).

The selection of evaluation method depends heavily on the resources available and the data collection methods selected.

Evaluation Method and Results

As we are not keeping track of 'hits[14]' of a product and we are not returning the full list of recommendations to the user, we opted to use the Lift Index method of evaluating the recommendations.

Using a small set of test users in a lab environment to also satisfy our evaluation of the mobile UI, each user was asked to rate the recommendations they received from 1 to 5, with 5 being most relevant and 1 being least relevant. Similarly, the friends of the users for whom the products were recommended were also asked to rate the results from 1 to 5. After using the Lift Index Equation and calculating each result as a percentage of the highest possible result, we determined that in 28% of cases, the recommendations were less than 70% accurate, in 43% of cases the results were between 70 and 80% accurate and in 29% of cases the results were over 80% accurate.
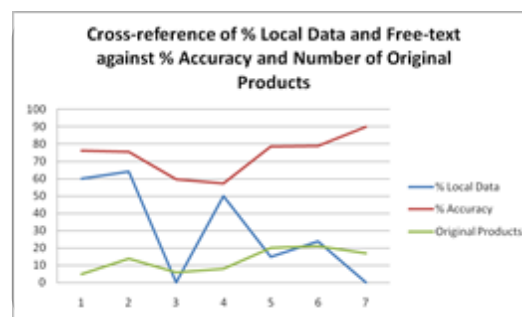
Figure 2- Graph Cross-referencing Local Data and Free Text, Accuracy and the Number of Original Products

We also determined that the 28% which had an accuracy rating of below 70% were due to two cases:
1) The friend was not in the pre-determined demographic for whom the test database was created and so no appropriate products were available.

2) The friend did not have very much information on their profile from which results could be gathered which is fortified by the fact that users who had a higher initial input also had higher recall of results and a higher percentage accuracy (See Figures 2 and 3).

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[14] The number of times a product was selected
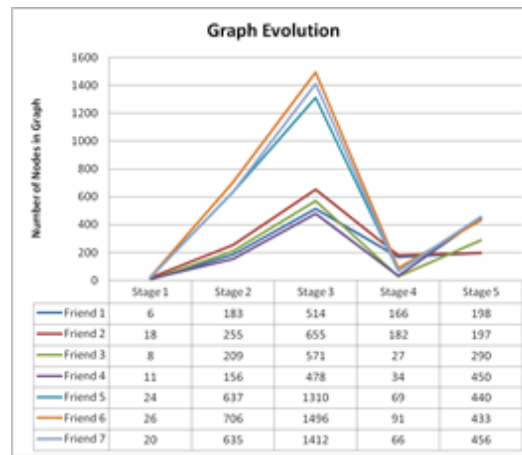
Figure 3 - Graph of the Evolution of the Concept Map throughout Processing

Due to our limited resources, we opted to evaluate the Mobile UI by using the Users in a Lab Environment method.

The method of evaluation led us to encounter three problems with our UI. One problem which occurred in three cases was that facebook™ would repeatedly ask for confirmation when a user exits the application after logging in and enters it again. Since this is from the facebook™ API and not something caused by our application nothing can be done to change it as it is also a security requirement.

Another problem that occurred was that users would have to scroll down an alphabetic list to find friends to post for recommendations. This would be problematic with friends whose names are later in the alphabet.

Finally we also encountered a problem where the system exited prematurely once. The reason for this is unknown and could have been caused by the user accidentally touching some part of the touch-screen Mobile device which caused the application to exit.

CONCLUSION AND FUTURE WORK

We have shown a new approach to recommendation systems while incorporating multiple technologies to yield promising results. In consideration of future work, the framework on which GiftFinder has been based where Information Retrieval is based on multiple sources and the data is weighted and filtered according to importance may contribute to the fields of Recommender Systems and Information Retrieval.

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Tweetalyser: A Twitter Based Data Mining System with Recommendation Capabilities

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ABSTRACT

Tweetalyser scientifically processes and stores the free information available in user tweets and extracts facts which are then used for item recommendation. The system proves that it is easy to tap into this data mine using low footprint social network APIs and third party technologies, in conjunction with the appropriate scientific algorithms. When at its full potential, Tweetalyser is able to provide useful information about a user which, when put in the right context can uncover true knowledge. From a social networking point of view, Tweetalyser has the potential of recommending and thus increasing attendance to various events. It also attracts newcomers who in turn crowdsource useful data elements to construct a truly formidable knowledge system.

Author Keywords

Social Network Sites, Text Mining, Data Mining, Recommender Systems, Web 2.0

INTRODUCTION

Ever since the invention of the Internet, web-usage has become much more than a daily occurrence in everyone's lives. This is a result of the advances in the area of web technology, making the Internet more important and present in business environments and private lives. Social networking and microblogging sites, such as Twitter are a recent phenomenon resulting from the developments made possible by the Internet.

With the ever rising popularity of these services and analogous microblogging systems, the study of the microblogging phenomenon is important to help turn the data mine created by the users' posts, into knowledge.

One distinct area in which tweet analysis is utilised is market research. Market research is the practice of collecting human opinions on a subject matter. Researchers are always looking for new, quick and valid ways of collecting relevant data. Using marketing as the context, this dissertation shows that the data collected from the user's tweets can be data mined providing the basis to a recommendation system.

AIMS AND OBJECTIVES

The system proposed in this paper is a Twitter-based data mining recommender system. Tweetalyser channels the user's already existing tweets into innovative knowledge representations. This system will include a web application that favours content sharing based on Web 2.0 patterns. The web application will ultimately serve as an interface and lure to aggregate user information. Furthermore, the web application, suggests social events based on the interests discovered from the users' tweets making the web application a recommender system. The user will then choose to 'attend', 'track', 'organise' or 'perform at' an event, providing Tweetalyser with statistical data about which users are interacting with the event. Interest discovery is achieved using the text mining algorithms developed on the user's tweets. The tweets are aggregated when the connection is established between the users' Twitter account and Tweetalyser.

The success of the system is characterised by how fast the system is able to process the data, the accuracy of the data collected and the seamless implementation of a Web 2.0 conforming web application.

To achieve the above, the objectives identified are:

- Building a database that will effectively store the data collected. Design of the database is to be based on scientific methodologies.

- Building a tweet mining module that will efficiently process the data retrieved in a timely fashion.

- Building a data mining module that will prove the potential of the Twitter dataset.

- Building a web application that conforms to the Web 2.0 patterns. This web application will act as an interface between the user and the automated system, ultimately providing the connection between the users' Twitter account and Tweetalyser.

Tweetalyser aims to provide a scientific method of analyzing the Twitter's dataset with the objective of aiding marketing through intelligent computer systems. The scientific contribution can be found in the framework proposed to allow for data mining of the Twitter dataset.

BACKGROUND

Social Network Sites

Social network sites are nowadays considered to be important, if not indispensable to millions of people all over the world, many of whom have integrated the use of such sites into their daily practices. A typical social network sites' main purposes are to reflect real life relationships or social groups on a virtual level and providing a medium over which to post text based posts. Relationships are represented as a group of links between the users of the site.

Twitter

Twitter, the succinct microblogging service, is a social network site that enables its users to send and read 140 character text-based posts called tweets. Tweets are displayed on the Twitter timeline and delivered to the author's followers15. Tweets are short and written and read quickly, making Twitter the ideal mode of communication for people on the fast lane who want to keep in touch and participate in group conversations with people from all around the world.

Each Tweet can be full of information, deeper context and embed media such as photos, video and other external links. Another important feature is the regularity with which each user updates their account. A typical blogger may post on his or her blog a couple of times a month; contrastingly a typical Twitter user posts multiple tweets a day.

Tweets are also categorised by Twitter users using hashtags. Hashtags are in themselves themes of the tweets. Hashtaging is done by pre-appending the hash '#' symbol before a word. For example a typical categorised tweet would look like this:

"My favourite #Tea is #EarlGrey".

Tweets can be sent and received through the Twitter website, by SMS or third party applications. Twitter's recognition and use is global, having a social network of users that "crosses continental boundaries". The ease of use of Twitter and its presence everywhere, from desktop computers to mobile devices, and the integration of the Tweet Button16 in many sites, has prompted people into sharing more. Findings indicate that posts are typically the sharing of daily experiences and personal opinions.

This information being shared is building a vast and varied database of information on a multitude of topics. This data is just waiting for researchers to turn it into useful knowledge. This study shows that collection and manipulation of this data can be done at a minimal cost and effort.

METHODS AND MATERIALS

Text Mining

Tweets, being short and constantly generated, are very well suited for knowledge discovery. To discover the knowledge hidden within these tweets, one must manipulate and analyse tweets in such a way that the computer can make sense of the text contained. Tweets therefore, need to be mined and transformed into data. Text mining is the process of extracting data from plain text. In the Tweetalyser system, text mining is used to discover the nouns, mentions17 and hashtags contained in the user's tweets. The resulting clean text is used to populate a database with the data collected from the tweets.

Text Refinement

Tweets contain conversational text, therefore, another important step before being able to mine the tweet text, is to clean the text from unnecessary words and symbols such as stop words, punctuation, emoticons, and internet slang. A list of pre-identified exceptions is drawn up and used to refine the text. More exceptions are discovered when testing the system and added to the exception list.

The Framework

The framework proposed for the text mining is based on the framework described by Wakil. The framework of the text mining system of Tweetalyser is as follows:

1. **Information Retrieval (IR):** The first step is to retrieve the text from the desired source, in our case connecting to the Twitter account and retrieving the user's tweets.

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15 Followers: people who subscribe to a user's tweets.

16 The **Tweet Button** situated on a web page lets users "share content" such as the link of current page on the Twitter timeline, "without having to leave the page" [5].

17 **Mentioning**: the act of mentioning a fellow Twitter user by preceding the Twitter username with the '@' symbol, for example: "@jack is the co-founder of Twitter." This practice is used to converse over Twitter.

2. **Information Extraction (IE):** In the second stage the facts[18] within the data are extracted, using formalised pattern recognition techniques, ultimately storing the revealed data in the database.

3. **Information Mining (IM):** Once the IE is successfully accomplished, the system is left with the raw data ready to be inserted in the database structure needed for data mining. Therefore, the patterns within the data are formalised relational tables.

Other techniques involved in the process of text mining to populate the database are:

1. **Feature extraction:** this technique deals with finding the particular pieces of information which are relevant within the text. The features identified for extraction were: nouns, hashtags, mentions and tweet locations.

2. **Thematic indexing:** sorting the data with respect to a particular theme. This is done by querying the database.

3. **Clustering:** grouping text upon certain criteria. In this case, facts pertaining to a certain user are clustered together.

4. **Summarisation:** describing the content of the text in the shortest way possible. Some content is summarised in the web application.

The above techniques are necessary to make the "textual information" held within the tweet "accessible", and "reduce the volume of text".

Data Mining

Data mining is the methodology used to ascertain patterns and relationships in large databases. "In general, data mining, sometimes" also "referred to as data or knowledge discovery, is the process of analysing data from different perspectives and summarizing it into useful information".

"Data mining tools predict future trends and behaviours, allowing businesses to make proactive, knowledge-driven decisions". Their automated nature allows analyses to go beyond analysing past events, but in reality puts this retrospective information to use in attempting to answer questions that are considered too complex to resolve.

When database systems are built on high performance client/server architectures or parallel processing machines, analysis tools can deliver answers to queries such as "Which users are most likely to want to attend my next event?"

Within Tweetalyser, data mining is used to interpret the patterns discovered in the text mining stage. The results are then showcased in the web application. Data mining is built on three pillars:

- **Data:** facts[4] about a certain subject. This data can be easily processed by a computer.

- **Information:** Information is derived from the study of the connections, patterns, and relationships between the data. Tweetalyser automatically discovers information such as: which friends a user mentions the most and which nouns and hashtags are used most.

- **Knowledge:** Knowledge can be derived from further analysis of information and putting into context. Through this analysis one can derive knowledge about possible future trends based upon past patterns.

With the continuous advancement in processing capabilities of computers and the availability of valid database software to virtually anyone, data mining has become easier to do and more cost effective.

Tag Clouds

A tag cloud is a visual representation of a weighted list of keywords. A tag cloud takes the text within the document, works the weights of each word in relation to the corpus and allocates the font size with respect to the word's weight. The word's weight is calculated by finding the word's incidence, referred to as frequency, in the text and dividing it by the total number of words to find its weight within the whole corpus.

f_{ij} = frequency of word in document
N = corpus size, (in this study the number of nouns discovered about a user)
tw = term weight

$$tw = \frac{f_{ij}}{N}$$

The above equation is adapted and used to determine noun, mention and hashtag frequency within the user's tweets.

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[18] Within the Tweetalyser system, facts are defined to be mentions, nouns, hashtags and tweet locations.

Recommender Systems

Recommender systems are systems which attempt to suggest information based on the user's interests. A typical recommender system makes suggestions upon comparing the user's profile to a foreign characteristic, thus being able to suggest items that are deemed to be most suitable to the user. The characteristics used for comparison may be twofold:

- **Content-Based Approach:** Items are recommended based upon the explicitly described user's interests and the description of the item.

- **Collaborative Filtering:** Recommendations are based upon the user's social environment. This approach suggests items based upon knowledge learned from analysing large amounts of data about the user, therefore the knowledge is of implicit nature.

In this study a combination of both approaches is used to offer to the user as many useful suggestions as possible.

The Content-Based Approach is used to make recommendations based on the user's interests. A user profile is formed when the system implicitly discovers the nouns, hashtags and mentions contained in the user's tweets. The user's nouns and hashtags are then compared to information about an event, resulting in the discovery of items that might interest the user.

Collaborative filtering is used to recommend events that interest the user's friends.
The web application acts as an interface that aggregates more facts about the user. This type of system is called a "user customization system". In this study the system has been designed to be able to learn more about the user incrementally; the more times the user signs into Tweetalyser, the more Tweetalyser learns about the user through their new tweets and social connections.

Web 2.0

A Web 2.0 web application must facilitate participatory information sharing, interoperability, collaboration and have a user-centred design. In modern day computing, a web application must have the above mentioned characteristics, so as to motivate the user to use the application. A Web 2.0 application encourages the user to collaborate with the other users, constantly persuading them to generate user-generated content, in contrast with systems that make users passively view corporate generated content.

The Web 2.0 concept has helped the World Wide Web flourish and unleash its full potential. The Web 2.0 concept puts forward eight patterns which are deemed to increase the value of a web application, namely:

1. Long Tail,

2. Data is the next Intel Inside,

3. Users Add Value,

4. Network Effects by Default,

5. Some Rights Reserved,

6. Perpetual Beta,

7. Cooperate, don't control and

8. Software above the level of a single device.

For a web application to be considered a Web 2.0 application it must exhibit the above eight patterns. Web 2.0 is highly driven on the notion of encouraging the user to participate and share content. Rather than having the developer provide the information, the users are encouraged to add value in the form of events to the web application.

DESIGN

The user's tweets are used to form the dataset. Once the user has given Tweetalyser access to his or her Twitter account, through the use of the Twitter API, the system is left with myriad information regarding the user which can be mined for multiple uses.

Consequently the methodologies described earlier are used to build a server-side module that mines the user tweets and populates the database. The relational database contains the user's tweets in their original state, as well as in their post-text-mining state. Next, Tweetalyser mines the database to extract knowledge from the data. This knowledge is used to recommend events from the system to the user according to his or her interests.

A scalar-valued function that calculates the distance between two tweets was implemented but no user interface was developed.

A Web 2.0 compliant web application is designed to act as the interface to connect the user's Twitter accounts and add value as well as encouraging sharing of content. The web application suggests users events that might interest them based upon the nouns, hashtags and users they follow compared to the event's nouns and hashtags, effectively mining the data held in the database.
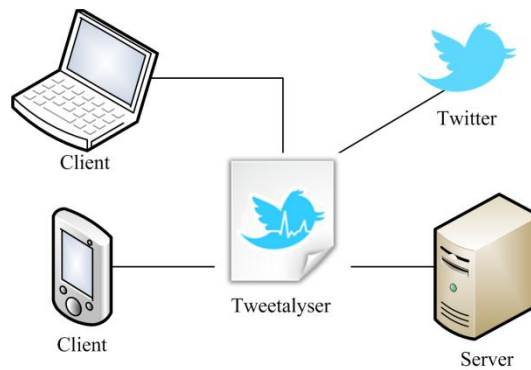
Figure 20: High-Level System Diagram

IMPLEMENTATION

Tweetalyser is developed using the model-view-controller (MVC) design pattern. This framework allows for agile development. In an MVC development environment, the Model holds the set of classes that manipulates the data in the application's database. The View section holds the application's presentation of the data stored. The views receive the user inputs, whose response is defined by Controller.

In Tweetalyser, the users' tweets form the applications Model. The Model is built using the text mining techniques on a user's tweets and populating the database with the nouns, mentions and hashtags. SQL stored procedures and functions clean the tweets and data mine some of the knowledge contained in the data.

The View section contains the interface that allows the user to add value. These views are designed to be clear and easy to use. To enhance viral traffic, the AddThis buttons were placed in crucial points of the page so as to encourage user sharing. Users are also allowed to add events they deem interesting, increasing user participation.

The Controller section contains the classes that calculate recommendations in real-time as well as defining the responses to be given for determined inputs.

The MVC framework used also helped develop an application which is above the level of a single device. This is achievable due to its server-side processing and HTML5 scripted views.

TESTING AND EVALUATION

Testing for bugs was carried out prior to the evaluation process. The evaluation of the system was done to provide a measure of how well the program functions, in terms of text mining accuracy and speed. Tweetalyser was also tested for usability. It was verified that the web application abides to the Web 2.0 patterns. The testing and evaluation is split in four:

- Data Model Evaluation;
- Quantitative Analysis;
- User Interface Evaluation;
- General system evaluation using S.W.O.T.

The Data Model was tested and evaluated using the Hold-Out methodology. This methodology divides the dataset into two:

- Training set,
- Testing set.

The training set was used to develop the model. Once the model was ready, the testing set was in turn used to check if the results obtained with the testing set were as accurate as the results obtained with the training set.

Quantitative analysis was done next. In the implementation stage, a measuring subroutine was implemented to populate a separate table with the start and end times of each text mining and data mining process, enabling the extrapolation of the analysis volumetric.

This table revealed that the average processing time taken to process one tweet is fifty-two (52) milliseconds. This means that three thousand (3000) tweets are processed in two point five (2.5) seconds.

The third and final part of the evaluation deals with the web application's usability. Usability is defined as the process of proving that the system may be quickly and easily accessed . Furthermore, the evaluation checked whether or not the web application does in fact abide to the Web 2.0 patterns.

The evaluators where asked a serious of questions to determine the web applications effectiveness, efficiency, engagingness, error tolerance, and ease of use of system for the first time user.

Overall, the system was found to be effective, efficient and engages the user. Error tolerance is perceived to be very high by the users who feel that no particular skills are needed to use the web application. It was also noted that the users who had few Tweets felt that maybe the recommendations could have been more relevant, while the remaining agreed and some strongly agreed that the suggestions given were relevant. The majority perceives the system to be fast and intelligent. The small percentage that felt that the web application was not intelligent have relatively few tweets. Finally, the greater majority adequately handles errors and is easy to navigate.

A checklist to conclude whether or not the web application has all eight patterns of a Web 2.0 application was drawn up. This was found to be true.

To conclude the strengths, weaknesses, opportunities and threats of the system were identified and the following figure drawn up:
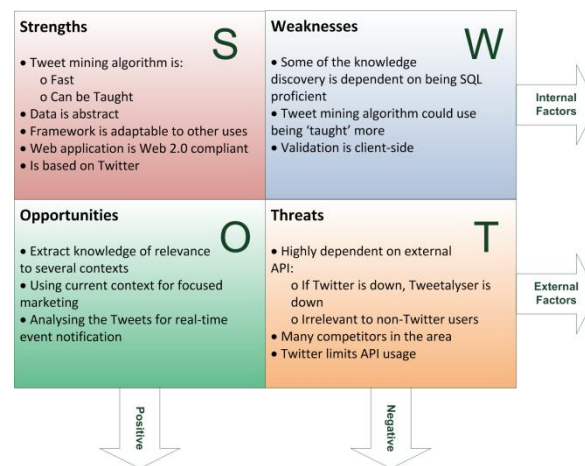
Figure 21: SWOT Matrix for the Tweetalyser

System

FUTURE WORK

In the light of the implementation and subsequent evaluation, the study was able to identify future work that can be added to the system. Future work is divided in two parts:

- Work that can be done using current framework; the system can be improved using the location data gathered, and the scalar-valued distance function developed.

- Work that can be done using an expanded framework; One consideration is that of retaining more data contained in tweets, such as the tweet's emoticons. These icons can be used for thematic analysis of the tweets.

The fact that the system developed is Web 2.0 compliant makes it a perpetual beta. Therefore, the possibilities for improvement are virtually endless. Thanks to the modular design of Tweetalyser, expansion can be easily done.

DISCUSSION

The primary objectives sought were to build a new scientific framework over which tweet analysis could occur. To achieve this, the study has strived to develop a database that could adequately store user tweets, using the new text mining algorithm that efficiently processes the data retrieved in a timely fashion.

Data mining algorithms to show the potential of knowledge contained in the Twitter dataset were developed and showcased in the Web 2.0 compliant web application. The web application also had the purpose to act as an interface for users to contribute to the Twitter dataset.

The evaluation results showed that the system developed, which met all the designated objectives, is quite robust and scalable. It has numerous opportunities for expansion, with few limitations that can be overcome with further development. Future improvements suggested, can lead to a scalable system which will find its application in a number of research-based projects.

Thanks to the increasing number of Social Network Sites which cover a number of domains, together with the increased variety of content-rich multitasking handheld devices and the advent of Web 2.0, the user with the most basic computer

skill, is given access to post anything anywhere. This is indeed contributing to the knowledge society where crowdsourcing becomes the ultimate data aggregator.

Both academic researchers and businesses alike are starting to appreciate the huge potential that this data possesses, both in the marketing field and in user behavioural patterns. This is shown by the ongoing research in the fields, and the ever-rising popularity of the use of such networks in the applied domains. Twitter provides a treasure trove of untapped resources to market researchers who delve into and mine this data source in search of opinions about their product.

Therefore, Tweetalyser proves that with the help of the freely available social network sites' APIs and third party libraries, researchers are able to tap into this database at a minimal cost and effort.

CONCLUSIONS

This dissertation investigated the possibility of developing a scientific framework over which tweets can be mined for user interests. The study has successfully provided all the objectives set out in the beginning. From the evaluation of the system it was found that the system developed was a strong system, has numerous opportunities for expansion, with little weaknesses and threats that can be overcome with a little to no effort and development. The system developed is a perpetual beta; making possibilities for improvement are virtually endless.

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Short Papers

Exposing Reflection on Accommodation and Assimilation in Mobile Language Learning

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ABSTRACT

MiniMandarinHowler is a mobile language learning tool for Mandarin designed to promote reflective accommodation and assimilation of vocabulary. Using an electronic dictionary interface to encourage usage, the program exposes the relations between different words to the user in a way that encourages mental links and differentiations between words, based on ideas from Constructivism and Connectivism. An evaluation approach is described to attempt to detect if reflection-in-action or on-action occurs while using mobile devices. Possible modifications are then discussed to enhance the reflective potential.

Author Keywords

Reflection, accommodation, assimilation, language, mobile.

INTRODUCTION

The *Howler Project* is an investigation into the use of user-interaction tracking with computer-assisted language learning (CALL) software for Mandarin, in order to automatically generate learning recommendations for those users. As part of this system, an Android-based mobile test-bed called *MiniMandarinHowler* (MMH) was developed for initial user feedback and to capture some data to help select likely useful algorithms for the main client software. The opportunity has arisen to develop MMH into a full-blown mobile language-learning program in order to evaluate reflective possibilities in mobile learning. MMH provides a simple electronic dictionary style interface to the user. They can view, sort, filter, create, and edit entries in their personal vocabulary database. Flashcard drilling and quizzing features are available. While using the program, the user's actions are being recorded. This data is exposed through a reflection interface that allows the user to see each item of vocabulary, and their own actions, in context. Work with this system is on-going. The motivation for, and design of, the system are given in the following section. The intended evaluation approach is then discussed and possible enhancements to the system are given in closing.

DESIGN

Background

Piaget's Constructivist processes of *accommodation* and *assimilation* (Piaget, 1983) suggest that individuals learn by incorporating new experiences within their existing mental framework. While this is an internal process, over the decades much research effort has gone into exploring ways to assist learners with it. The approach used by MMH is to expose the user to the interconnections between vocabulary items, and to statistical information about individual items. Explicitly showing items related by definition, pronunciation, lexical category, or orthography allows the learner to see an already-adapted framework that incorporates an individual item and serves as an example for the learner.

Connectivism is learning theory with the idea that knowledge is embodied in the web of associations between concepts, rather than necessarily in the concept itself (Siemens, 2004). This web of associations rather neatly maps onto the inter-relations between vocabulary items in a language. Meanings of words relate to their use in a language, and to the meanings of other words, therefore visualising their place according to word properties may provide a template for learning such associations.

Language learning has a particular desire to use authentic content in authentic settings (Duquette, 2007; Rogers 1998; Wong 2010). This situates the learning in the real world and makes its relevance more obvious to the learner. Mobile language learning has an obvious advantage here in allowing the use of mobile learning programs while actually in such a setting. They can consult existing items, add new items, and use the visualisation provided by MMH to expose related items which the learner would not have initially considered, while still within the situation in which they are relevant.

MMH Design

MiniMandarinHowler is an Android application with four major interfaces. A *list screen* lists, potentially sorted, all the items in the database matching the user's desired search filter. A *word screen* displays details about a selected word. The

user can navigate between other words in the current filter by swiping the screen left or right. Individual details are interaction-sensitive and change the search filter to display words appropriately related to the detail interacted with (e.g., clicking on pronunciation returns other words with elements of that pronunciation). Figure 1 provides two screenshots of this screen. A *flashcard screen* provides drilling and testing on a user-defined subset of words. It can also be populated with pre-defined "pedagogically useful" subsets such most wrongly-guessed words, or words which are due to be tested according to a spaced-repetition scheme. Finally, a *reflection screen* exposes the inter-relations between words (see below).

The dominating user-interface principle was to allow the user to seamlessly and effortlessly navigate between vocabulary items without fear of being overwhelmed by the number of possibilities. The "back" facility in Android applications has been used to ensure the user can return to previous points by continually pressing "back". The interaction-sensitivity of each word property allows simple, fast, and casual exploration of related words.
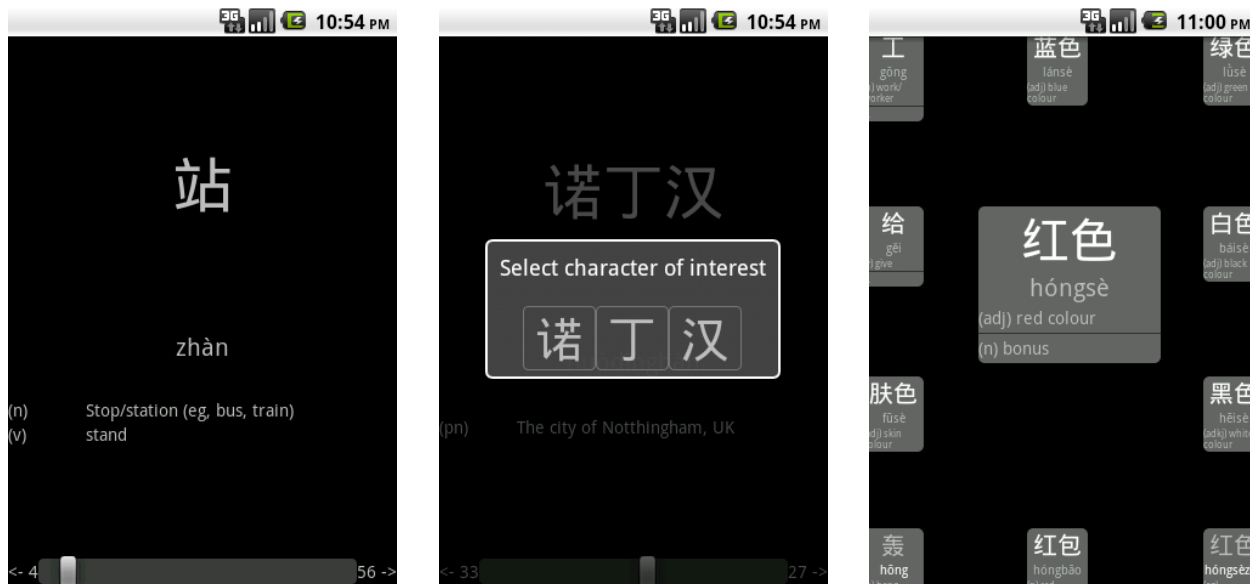
Figure 1. (Left) Word view. (Centre) Interaction sensitivity explores related words from characters in the current word. (Right) Reflection view with current word in centre and related words on edges. Reason for relation is highlighted in white.

Reflective Screen Design
The design of the reflective screen was chosen to emphasise the connections between words and allow them to be fluidly traversed. The currently selected word dominates the display in the middle of the screen, showing some of the details available in the word screen. Surrounding the word around the edge of the screen are representations of related items. These are displayed as miniaturised, abridged views of what the item would look like if it were the currently selected one. The number of these related items is limited to one per corner, one per short edge, and two per long edge to allow separation for display and easy input in a phone form-factor. To switch to one of the related items the user swipes that representation into the middle of the screen. A screenshot of this screen can also be seen in Figure 1.

Items are selected for these edge spaces by being related by definition, pronunciation, lexical category, or orthography to the selected word. This is how the accommodation and assimilation process is exposed and scaffolded. User interaction data also has a large role to play in the selection of related items; words which the user views or edits often, or which have been recently added or edited, are given priority to be displayed in one of the limited number of screen spaces available. This is done in order to maximise the user's exposure to words he may not yet have fully adapted into his framework. The user also has the option of automatically populating a flashcard drill/quiz with the word and all its related counterparts.

Expected User Behaviour
The user is expected to primarily use the electronic dictionary functionality provided by the program. This provides the direct support to their language tasks that a physical dictionary would. For the learner to use the reflective interface they must first see a use for it. To encourage adoption it will be referred to using more end-user friendly phrasings such as "see related words". Therefore, the first few times the user encounters the interface they will have an idea of its purpose. Subsequently, the user will start to explore the network of connections out of curiosity, and thus be surreptitiously scaffolded to reflect. The form and extent of the reflection is entirely up to the user; the program offers no further functionality beyond navigation and flashcard auto-population. This is in order to avoid distraction from the associations presented since they contain the implicit language knowledge that needs to be acquired.

EVALUATION
Evaluating reflection directly is difficult due to its internal and subjective nature (Schutz, 2004). While it is possible to evaluate how well a learner follows a reflective *procedure*, such a procedure is proscribed by the implementation of MMH. Instead, the usefulness of the reflection provided will be evaluated via correlations between usage of the feature and any

proportionate increase in language ability, and by qualitative user focus groups. This aligns well which the participants of the study who will be informal, semi- or un-directed language learners who have differing levels of ability. Pre- and post-tests will be designed to measure their language ability and breadth of knowledge. While this evaluation strategy admittedly lacks the conclusiveness of more controlled approaches, it does allow the raw revelation of giving a pedagogically useful tool to learners then allowing them space to "see what happens" when they have it. Since the author is unaware of any existing mobile system focusing on provoking reflection in the proposed way, there are a large range of possibilities to capture. This high risk approach is also mitigated by the frequent availability of possible participants through-out the host universities language programs, and their general willingness to try new approaches to learning, and echoes the iterative prototyping approach of agile development methodologies in software engineering.

One particular line of investigation in the user focus groups will be to try to identify when reflection with a mobile device takes place. Schön wrote of *reflection-in-action* and *reflection-on-action* as the ad-hoc reflective, experimental practice during an event, and the more deliberate recapping and analysis after an event, respectively (Schön, 1983). The distinction between these is rather debatable. When does reflection stop being part of an event? And what of reflection on a previous event during a later event? Studying *use*-in-context is a basic part of mobile system research; this study will reveal if *reflection*-in-context occurs with mobile systems. The hypothesis is that very little reflection-in-action will occur but there will also be a very large deviation in the amount of reflection-on-action undertaken by different participants based on their learning approach. This is hindered, however by the likelihood of the study being conducted in an environment outside of the learner's target language, as discussed below.

DISCUSSION

As noted, this work is currently awaiting studies being performed and therefore has no concrete results to report. Initial user exposure however, has resulted in positive feedback on the potential usefulness of the system. In particular, users saw the use in the reflective aspect of the system without explicitly explaining its reflective nature to them.

An unresolved issue in evaluation is that of authentic contexts. Users of the system will not be located in an environment which uses their target language. Language situations are unlikely to arise outside of set-piece educational situations. This will markedly reduce the possibilities for authentic contexts for reflection. Currently, there is no available solution to this. However, should this work produce promising initial results, it will become possible to access exchange students who are immersed in their target language. Such a situation would dramatically improve the amount of data available.

The presented system is limited in its scope due to its initial purpose. The reflective view of word associations is split from the routine usage of the system in order to capture data about it. If users exhibit no problems with navigation in the reflective view then in the next iteration it will likely be used to completely replace the detail view of a word, continuously exposing reflective capability to the user. Rich mobile capabilities such as location tracking and image and sound capture are unused in this program. All three may allow vocabulary to be better situated in context. Finally, the full Howler Project, from which this program originates, combines interaction and vocabulary data from all users before data-mining to provide a collaboratively-derived framework for reflection. This was not included in MMH due to the complexities of doing so on a mobile device, however, should results indicate mobile reflection was useful it will become worthwhile to implement to discover if mobile group-reflection is useful.

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A study of the perceptions using Mobile Learning in Higher Education in Hong Kong – the end of textbooks, the rise of collaborative tools

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ABSTRACT

A study of the use of mobile learning with a group of higher education students in Hong Kong in Jun 2010 reveals that mobile learning is considered to be an effective method for learning and can facilitate new learning content to be constructed. All the participants of the study agree that sharing-editing-collecting is much quicker when Mobile Learning and Web 2.0 are used in combination and no one disagree that Mobile Learning and Web 2.0 can facilitate learning anywhere. With 58% willing to read textbooks using mobile devices like iPad and tablet-like e-Readers, the textbook industry is facing a different challenge from the increasing use of collaborative web 2.0 applications for learning.

Author Keywords

M-learning, collaborative learning, technology enhanced learning, higher education,

INTRODUCTION

Mobile Learning means any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies (O'Malley et al., 2003). The concept of mobile learning in Asia is growing (Chun & Tsui, 2010), and particularly in Hong Kong, the use of mobile data services are well over 50% (OFTA, 2010). In the book *Disrupting Class,* Christensen et al (2011) suggested that online platform tools and facilitated networks will transform the education industry to a student-centered and collaborative learning environment - suggesting that college students to "*expand learning by delving into the online expansions of their textbooks".* Our research study identifies that the post-secondary students in Hong Kong supports the use of Mobile Learning and collaborative web applications.

BACKGROUND OF STUDY

In the past twelve months, our team have sent out over 1150 online questionnaires and have administered various semi-structured interviews with students studying in higher education - as part of our ongoing research project in applying mobile learning to our ClassBooking system as a facilitated network based on HELP framework - Heterogeneous E-learning Portal (Chun & Tsui, 2010) In this paper, we are only presenting the results in our quantitative study held in June 2010. Reviewing previous work and literature shows that King Saud University of Saudia Arab have conducted similar study in 2008 of a random sample of 186 female undergraduate students aged between 18-26 using a questionnaire administered in various classes spread across three colleges (Al-Fahad, 2009). In our study, we found that the students in Hong Kong are very supportive in general to the concept of Mobile Learning. In April 2010, just when the Apple iPad has been newly released to the market place, we started to design our questionnaire and defining our sampling strategy as well as planning our recruitment process as part of our overall study.

DATA COLLECTION AND FINDINGS

The first generation of the Apple iPad was released in 2010 and about the same time our team completed a survey in Jun 2010 polling 204 students attending a Higher Educational institution in Hong Kong about their perceptions of the use of mobile learning and collaborative web applications (such as blogs, wikis, youtube). These students are all over 18 years of age with a majority of them still living at home. A briefing session in early June were provided to the students, a total of 1150 email invitation to participate in this survey; we were able to recruit a total of 204 participants corresponding to the response rate of around 17.7%. The collection process uses Google forms with the online questionnaire designed to be short with a total of 10 questions, separated into the two parts. Part 1 consists of seven (7) questions and was designed using Likert scales of response (Strongly Agree to Strongly Disagree) which explores the participants' perceptions of Mobile

Learning towards their learning environment and habits. The second part of the questionnaire consists of 3 questions designed to probe the participants' current preferences towards the use of Web 2.0 and Mobile technologies. Shown below are some descriptive statistics found from our study.

Statement/Question	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Q1 MLEARN is an effective method	**51%**	43%	5%	0%	0%
Q2 MLEARN allows new courses to be built	46%	**50%**	3%	1%	0%
Q3 Web 2.0 Tools are useful to their learning	35%	**45%**	6%	14%	0%
Q4 MLEARN + Web 2.0 Assessment and Test can be completed faster	28%	**50%**	14%	8%	0%
Q5 MLEARN + Web 2.0 can improve teacher student communication	26%	**50%**	22%	1%	0%
Q6 MLEARN + Web 2.0 quick to collect/edit/share data	49%	**51%**	0%	0%	0%
Q7 MLEARN + Web 2.0 flexible to learn anytime anywhere	27%	**61%**	11%	0%	0%

* Sample (n=204)

Table 1.

Question 1 probes the respondents on how they perceive Mobile Learning as an effective method of learning. From the sample of n=204, only one (1) person disagree. *94% of the respondents agree that Mobile Learning is an effective method.* Question 2 probes the respondents on whether they concur that Mobile Learning can facilitate new courses and learning content to be built, only two (2) persons disagree. *96% of the respondents agree that Mobile Learning can facilitate building new courses and learning objects.* Question 3 probes the respondents on their perception of the use of Web 2.0 tools as useful for their learning activities, twenty-eight persons (14%) disagree. *Over 80% of the respondents agree that Web 2.0 is useful for learning.* Question 4 probes at the respondents on whether Mobile Learning and Web 2.0 tools can make test and assessment faster, seventeen persons (8%) disagree. *Over 78% of the respondents agree that Mobile Learning and Web 2.0 can make all test and assessment faster.* Question 5 probes the respondents on whether Mobile Learning and Web 2.0 tools can improve communication, three (3) persons (1%) person disagree. *Over 76% of the respondents agree that Mobile Learning and Web 2.0 can improve communication.* Question 6 probes the respondents on whether Mobile Learning and Web 2.0 tools can be quicker for sharing-editing-collecting data. From the sample of n=204, everyone agrees. *100% of the respondents agree that Mobile Learning and Web 2.0 can make sharing-editing-collecting data quicker.* Question 7 probes the respondents on whether Mobile Learning and Web 2.0 tools allow learning to be done anytime anywhere. Nobody disagree. *Over 88% of the respondents agree that Mobile Learning and Web 2.0 offers flexibility for learning anytime anywhere.*

8. Which type of Web 2.0 Tools have you used ?

Blogging (writing)	90	44%
RSS Feeds (reading0	62	30%
Forums (discussion)	131	64%
Youtube (reading and writing)	159	78%
Skype (collaborating, whiteboard)	51	25%
Other	7	3%

People may select more than one checkbox, so percentages may add up to more than 100%.
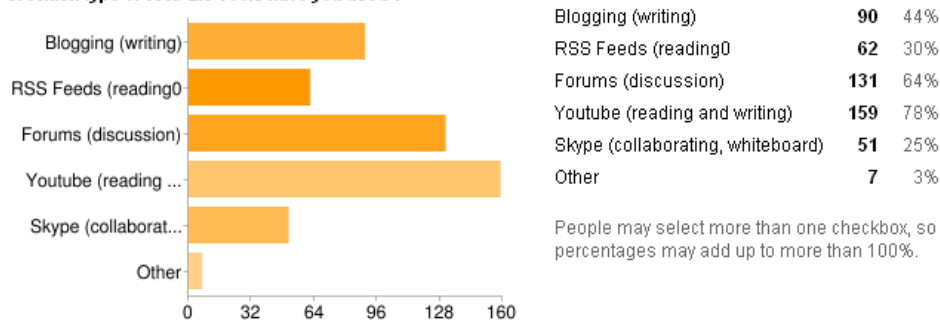
Figure 1.

9. Which one of the following do you use most ? Wi-Fi, 3G, HSPDA or GPRS ?

3 or 3.5G	48	24%
HSPDA	16	8%
GPRS (eg. Peoples)	29	14%
Wi-Fi	171	84%
USB 3G	62	30%
None of the above	7	3%
Other	2	1%

People may select more than one checkbox, so percentages may add up to more than 100%.

Figure 2.

10. Would you be like to read your text book with an iPAD or any new Mobile e-Reader

Yes	**119**	58%
No	**85**	42%

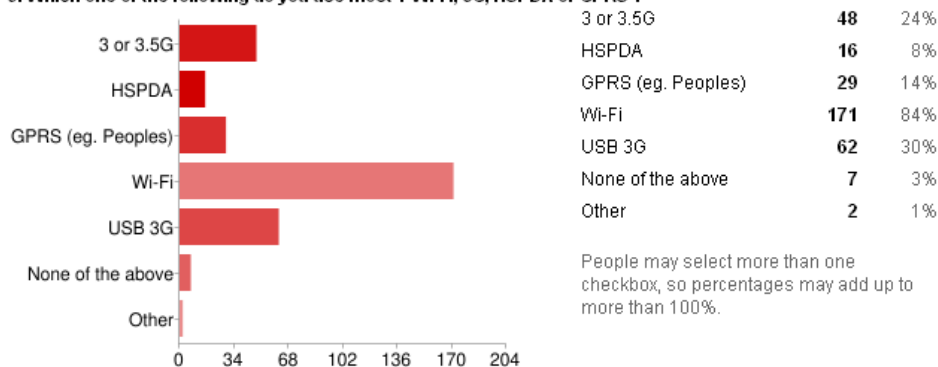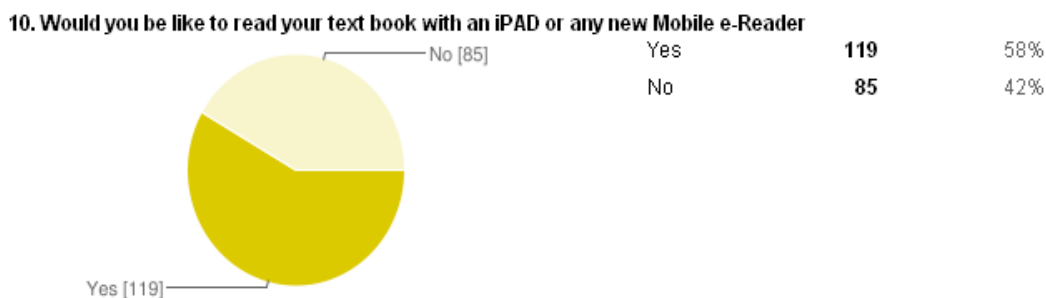**Figure 3.**

The second part (Question 8,9 and 10) of the questionnaire probes the respondents on the type of Web 2.0 tools, mobile services most frequently used and finally the desire to use any form of e-reader or iPad to read textbooks. Some of the above Web 2.0 features and technologies were prescribed to the respondents and as such, there may be more other innovative use or new Web 2.0 tools.

The descriptive statistics presented in Question 8 is reasonable compared to the official 50% mobile data penetration (OFTA, 2011) For students, the statistics suggest a story that not all students will pay or can afford mobile data plan. The outcome is they will use alternative mode of access. The most affordable access of high speed internet in Hong Kong is Wifi. This can be logically explained as HK students are given free student accounts to use one of the HK Public Wifi network operator and campus-based, establishment-based, government Wifi hotspots are abundant in a metropolitan city like Hong Kong.

The desire to use e-Reader or iPad to read textbook is an interesting statistic. First of all, iPad and purpose-built e-Readers were only just released back in early 2010 and the question is not rooted with any specific price point or sensitivity in mind. The result is a marginal majority and clearly replacing textbook in the traditional sense is not immediate. Over 58% agree to use mobile device like iPad for reading textbooks. Christensen et al (2011) however had suggested the textbook publishing market is in the danger of being replaced by newer software platform and user-generated content. The analogy that he puts is the camera and film industry. The reading habits and use of text-book may not be displaced, but the form of consumption could be. Further work and on a monthly basis, the perception and adoption curve will change due to price.

LIMITATION AND FUTURE STUDIES

This study is limited to studying one higher education college only and without knowing the detail demographics of the participants. Our project is an ongoing one and is currently going through the data collection coding phase of our constructivist approach of grounded theory – to develop a theory based on the experience of the students.

CONCLUSIONS

Hong Kong has a very high mobile penetration, high adoption of mobile data and public WiFi services, these external factors may be an important factor to consider for successful adoption of mobile learning projects. In our study conducted in Jun 2010, we sampled 204 students aged over 18 studying full time at a higher education college. The study reveals that the students strongly support the notion of mobile learning and using collaborative web 2.0 technologies for their learning. It also reveals that more students are ready to use mobile devices for consuming reading of textbooks, and many of which participate in various discussion forum, blogging and video for learning purpose.

ACKNOWLEDGMENTS

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Learning from Formative Evaluation in Use: a Case Study of a Mobile Application for Language Learners

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ABSTRACT

User centred design attempts to make as much reference as possible to the eventual end-users of a new piece of software. In the context of technology enhanced learning applications, learner-centred design is the relevant goal, and a plethora of methods and techniques have been used in order to probe learners' behaviours and attitudes about proposed new functionality. However, the usability, acceptability and usefulness of some aspects of functionality are extremely difficult to gauge without extensive use of a working prototype. This paper describes the formative evaluation programme for a mobile knowledge sharing app and describes three perspectives on learners that were identified from evaluation in use, but that would not be visible in short term and/or lab-based evaluation.

Author Keywords

Mobile language learning, learner centred design, formative evaluation

INTRODUCTION

Practitioners of user centred design in a range of domains attempt to make as much reference as possible to the eventual end-users of a new piece of software (Norman & Draper, 1986). In the context of technology enhanced learning applications, learner-centred design is the proclaimed goal, and a plethora of methods and techniques have been used in order to probe learners' behaviours and attitudes with respect to proposed new functionality (Sharples et al, 2002; Good & Robinson, 2006; Pemberton et al, 2005). Key tools used in the initial design phase include personas, scenarios, use cases, role play and low-fidelity prototypes derived from user research, as well as design knowledge drawn from guidelines, patterns, competitor analysis and relevant theory. Once a prototype is developed, whether lo-fi or hi-fi, a learner centred design project will typically engage potential learners in evaluation of usability and acceptability (Rudd et al, 1996). Lo-fi protoyping has been claimed as an effective design tool for mobile applications (Svanæs & Seland, 2004). However, there are limits to the information that can be extracted from end users without the existence of a robust, fully functioning prototype, in use for an extended period, which gives learners a realistic impression of the intended application. This seems to be especially the case when an application is designed for use in informal settings, with exact modes of use determined by learners rather than teachers. In this paper, after a brief sketch the development of a first working version of a mobile application for language learners (Pemberton et al, 2009), we discuss the feedback gained from a five week evaluation of the system, with a focus on those details of functionality and usage that, we suggest, could not be predicted from a short-term and/or lower-fidelity evaluation regime.

BACKGROUND

The system we describe has been developed so far in two major phases. The impetus for the original system was to develop a mobile (Android) app that would enable advanced language learners to collect and describe multimedia language and culture-related content they came across in everyday life within their target language culture. They could upload these content items to a repository for sharing and for editing and discussion via a Web interface. The system was developed over 18 months with the involvement of two user groups and the use of a range of conventional learner centred design techniques including personas, scenario, use cases and lo-fi prototypes (Pemberton et al, 2009). The system was evaluated with learners and a redesigned system is currently being implemented as part of a further project (Phase 2).

METHOD

The evaluation of the Phase 1 system took place over five weeks of July/August 2010, with six international students (average age 21 years) and two of their teachers. All the students already owned a smartphone with internet access, though none had used their phone for language learning. They were all very familiar with online services, including social networking. Students and teachers were each provided with an Android smartphone on which the application was pre-installed. Students were not provided with model entries to guide them and only received a short introduction to the

system. These were conscious decisions in the evaluation design as the design team was interested in a) how students would use and appropriate the system (independent from our own views of how the system *should* be used) and b) whether the system was easy enough to understand and use without training. Students and teachers were then interviewed and their responses analysed for design insights: we exclude the details of the data analysis for space reasons.

FINDINGS

As the aim of the evaluation was to provide formative feedback for the further development of the application, this section is structured around problematic issues relating to the current implementation and evaluation design rather than assessing system usability and trying to evidence learning.   In particular, rather than give an exhaustive list of design problems, some of which would be of little general interest, we try to identify *types of feedback* that emerged from evaluation in use but that had not appeared problematic during the early design and lo-fi prototype evaluation sessions. They fall into three broad categories, each refining an aspect of our understanding of the user group that was previously unclear.

Clarifying our picture of the users as technology users

We knew that our learners were smartphone owners but underestimated the extent to which an extra device would inconvenience them and also the extent of their grasp of the rather abstract concept of tagging when applied in a new context.

Phone ownership

According to both teachers and students, the main problem in the field trial was that students could not use their own phone but had to use the Android phone provided on which the CloudBank application ran. This not only touches on issues of ownership and previous knowledge of how to use the device (Jones & Issroff, 2007), but also practical issues of carrying around a secondary phone (and charger) and not having the device readily at hand when a learning situation arises.

Tagging content

Instead of pre-defined categories, the current system implements tags, which can be used for user-defined categorisations of content as seen on blogging platforms and, in combination with the tag filtering system, for the creation of ad-hoc interest groups similar to the use of hashtags in the micro-blogging service Twitter.   However, feedback indicated that neither students nor teachers had understood the role of tags in the system and the functionality was not used.   Instead students suggested that they would like to assign content to (pre-defined) categories, which would provide context and also help them to sort and find relevant content. The new system will introduce a set of global categories (and abolish the un-used tagging mechanism implemented in the earlier version). User group administrators will be able to select a subset of the global category set for their specific user group.

Clarifying our picture of the users as learners

We set out with a rather idealistic picture of the learner as a confident, highly motivated enthusiast, comfortable with active, non-didactic learning models: in practice, the picture was found to be more complex.

Motivation for independent learning

All our learners were notionally of the same language level. However, the teachers pointed out that it would take a certain level of confidence and maturity for students to be self-motivated enough to go out and find things they did not understand and ask questions about them, and this observation was borne out in practice, with only one student, older and more fluent than the others, using the system to its full extent as intended. The lesson we took from this finding was that the application needs to be directed to advanced learners or to intermediate learners supported by a teacher, but not to independent intermediates or beginners.

Confidence in target language

A related point is that of students' levels of confidence in operating in the target language. Teachers and students both noted that it was difficult to operate the system in a language one has yet to learn: the new system will therefore separate operating language and target language, and provide functionality to set the operating language according to the user's preferences. More pertinently, many student entries were submitted without context and description, which again was attributed by teachers to a lack of confidence about free writing in the foreign language. To lower the threshold for less advanced students, they suggested that the application could offer a dual-language mode where descriptions could be provided in the student's mother tongue, and this option will be incorporated into the Phase 2 design. Another explanation offered for missing descriptions and generally incomplete entries was that students in the trial started out with an empty repository and had no examples on which to model their contributions. In this context it was suggested that seeding the system with model entries might be helpful to learners.

Confidence in active learning models

A cultural issue discussed with teachers was that many students, particularly from the Far East (Oxford & Anderson, 1989), are more used to the traditional transmission model of learning than to independent learning: it might seem absurd to these students to go out and, in effect, create their own dictionary. This issue had in fact been raised in our Phase 1 design workshops with students, but we decided to follow through with the active learning concept. The lesson we take away is not to reject the application's active learning concept but rather to work on embedding the application in a supportive context.

Clarifying our picture of the users as social networkers

A third area in which we learned we did not have a full enough understanding of our learners' knowledge and preferences was in the area of social networking. In the evaluation, it became clear that experience of applications such as Facebook played an important role in learners' expectation of some aspects of the mobile learning application.

User identities

The current system is *anonymous* in that content is not associated with its contributor and there are no user identities. This was a conscious design decision as it was thought that students might be embarrassed to share what they did not know and only learned now, feel insecure about descriptions they provide or hesitate to share and admit their interest in vocabulary related to taboo subjects (e.g. swear words). Students however stressed that they would like to have identities on the system and that this would make it more fun and interesting to use. They denied that having an identity would inhibit contributions, insisting that contributing under their identity would raise their profile in the community and also motivate them to monitor and follow up entries by their friends. The new system will therefore support user identities.

Multiple entries, ratings, comments

The Phase 1 system works like a wiki in that content submitted by one user can be edited and extended by everybody else, ideally leading to a successively refined entry complete with description, tags, image, audio and web link. Consequently, the current system does not support comments or links. This style of knowledge building provoked much discussion. Teachers pointed out that students might not be confident enough to edit someone else's content but instead might find it easier to comment on entries or add an additional entry with their own description and/or media for the same word or phrase. Teachers also suggested that they would like to be able to comment on content for clarification, feedback and encouragement. This facility has been included in the Phase 2 app. Additionally students and teachers both suggested a rating system for entries, familiar from social networking applications, that would help to rank entries and grade their perceived usefulness. Such a rating system would allow 'good' content to 'bubble up' in the list of definitions while weaker contributions would sink down in the list and become less prominent. The new system will support a Thumbs Up / Down rating mechanism for user-generated content.

CONCLUSIONS

Although initial learner centred design is necessary, it is not sufficient to guarantee a design that stands up to sustained use. Evaluating the mobile app in use over five weeks highlighted a number of issues related to understanding our end users as technology users, as learners and as social networkers – that had not appeared problematic in our initial user research, design and lo-fi prototyping stages.

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Development of Mobile Learning in Kazakhstani Higher Education

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ABSTRACT

In the modern Kazakhstan society, the main development trend of information technology is a widely using of mobile communication systems. Despite of the fact that the level of general literacy rate in the country is one of the highest in the world, but level of information literacy in Kazakhstan is still low. Kazakhstan is a unique country - with a vast territory that is included in the top ten countries of the world, and with the very small population. This entails a problem in the development of ICT and dissemination of information. The Government is taking the systematic measures to improve this situation. The important role in development of this field plays the educational institutions. Today, there are still many problems with using in universities the entire spectrum of information technology, especially mobile one. We attempt to analyze the existing situation on the implementation of mobile learning in the educational process. We will try to identify the conditions and recommendations for a more intense and widespread dissemination of mobile learning in Kazakhstani higher education.

Author Keywords

mobile learning, Kazakhstani higher education, mobile technologies, Government Program.

INTRODUCTION

Modern Kazakhstan is a dynamically developing country with vast territory and a very small population. After start of Independence process in 1991, the economy faced with big problems and had reached a crisis state. This situation negatively affected on the spread of the information technologies and the introduction of new directions for technical progress in the social and economic spheres. By the end of 90-ths, the economic situation had leveled off and there were all possibilities for intensifying the implementation of information networks. In the 2000's years the widespread development of information technologies was becoming one of the main trends in Government economic strategy. This period is characterized by pervasive spread of mobile networks and different Internet services. By the beginning of 2011 year the degree of development of information technologies in Kazakhstan reached a maximum level for the all period of Independence. However, on the other hand the level of information literacy among the population is still low. This is due primarily to the low population density and concentration of information technology sector priority only in two big cities - Astana and Almaty. Perhaps the situation may improve more intensive with introduction of mobile communications technology and mobile Internet.

It is also important to note that most mobile operators are concentrated in two big mobile communication companies that monopolize this economy sphere. These conditions are significantly inhibiting the promotion of digital culture among citizens and wide dissemination of information flows. This situation can be improved by coordinated action between Governments, businesses sector and educational institutions. At many Kazakhstani universities actively are introduced the most advanced information technologies. Students and teachers are the most active groups of Internet users in the country. Among young people are becoming especially popular the mobile Internet services. Kazakhstani scientists in recent years been actively engaged in studying the implementation of information technologies in educational process. Certainly, there aren't any scientists who directly studying the mobile learning in Kazakhstan. But many researchers are investigating the pedagogical aspects of ICT.

We try to show some scientific works that describe the situations of using ICT in higher education. The investigations of A.A. Nurmagambetov describe the characteristics of informatization in higher education and use of new information technologies in educational process [1]. The scientific articles of A.B.Bekenova present the methods, models and facilities of planning and management of university - based on information technology [2]. K.L. Polupan has adapted the model of developing computer diagnostic quality of education's students [3]. N.A. Aldabergenov considers in his dissertation thesis, the professional training process of students in information technology sphere [4].

THE CURRENT STATE OF MOBILE TECHNOLOGIES IN KAZAKHSTAN

Last past decade in Kazakhstan there was a process of intensive development of information technology. According to reports of the Agency of the Republic of Kazakhstan [5] the number of Internet subscribers per 100 populations is growing intensively. If in 2004 year the number of Internet subscribers reached 203,000 people then in 2011 year this figure increased to more than 5 times and rose to 1.034 million subscribers.

Internet services strongly developed in five main areas: 1) Communication; 2) Searching of information and online services; 3) Purchase and sale of goods and services; 4) Contact with the public and state organizations; 5) Occupation, education, skill development. However, we can observe the noticeable decline interest in education sector among all subscribers. From 2007 to 2009 years, this figure fell doubled - from 39.9 percents to 23.6 percents respectively. Number of mobile telephone subscribers per 100 populations has increased from 2004 to 2011, nearly 8 times (16.3 percent and 123.3 percent respectively). The number of subscribes that use mobile phone for Internet connecting was 12.5 percent at the beginning of 2011 year, (about 130.000 persons). This is a good figure, considering that the population of Kazakhstan is only 16 million people).

Almost all indicators Kazakhstan has low level of ICT development behind other developed countries of the world. This situation indicates the inadequate use of information and communication technology as a business community and the population. Especially Kazakhstan has problems in the deployment of 3G and 4G telecommunication networks.

DEVELOPMENT OF MOBILE LEARNING IN KAZAKHSTANI UNIVERSITIES

In December of 2010, Government of Kazakhstan presented the "Government Program of development education system since 2011 to 2020 years" [6]. The main aim of this program is the development of the human capital. But the special attention is given to active using of electronic learning in all levels of educational country system. As it was declared in Program - in the next 10 years Kazakhstan system of education will be develop new training technology (as mobile learning) in different education institutions.

In March of 2011 year Ministry of Education carried out the Second International Conference "Distance Technologies in Education - 2011". The scientists from different countries discussed on this conference, for the first time, about the problems of developing the mobile learning in Kazakhstan. Some commercial services of mobile learning also were introduced in 2011. These services help Kazakhstan subscribers to teach foreign languages on their cell phones. For example, British Council and GSM Kazakhstan have presented new mobile service "Phrase of the day", with the use of which all subscribers will be able to learn English words through SMS, using the materials of the British Council [7].

We should to state that today the implementation of mobile learning in Kazakhstani higher education is not so intensive developing as other form of education. Here we can describe some separate elements of using mobile technologies in universities, but unfortunately it doesn't work as systematic conception. Some Kazakhstan universities have new structures and stuff workers who can implement new ways of education technologies in higher school. For example, at Kokshetau State University was presented the learning laboratory of innovations in education management spheres. The main aim of working active in this new structure is focusing on innovative solutions for implementation of electronic and mobile learning. At Karaganda Economic University was introduced a WAP testing system students. This system was built as a part of university distance learning system.

One of the first universities that started to implement new information technology in Kazakhstani higher education is Eurasian National University in Astana. In all campuses and buildings of ENU is working the local wireless network with free access to Internet. Teachers and student more and more prefer to use different handheld devices in everyday learning activity than their laptops. ENU is the first university in Kazakhstan that starts to active use Web 2.0 services. For example today the news and educational information about ENU reflect on system of micro blogs – Twitter, social network – Facebook and video hosting - YouTube. It was made special for students who prefer to watch new information on mobile devices.

CONCLUSION

We assume that mobile learning in Kazakhstan has a great future. Despite on there aren't still the global and fundamental investigations about mobile learning phenomena. And many scientists are only beginning to explore this problem. Material and technical basis of many universities is ready to implement projects in development of mobile learning. In this crucial period in Kazakhstan needs to create recommendations for educational support of mobile learning in universities. It is necessary to produce universal model of mobile learning and in our opinion, the most important thing - learn of educators how to use the all opportunities of mobile learning in their academic work and practice. First of all we need to conduct some research in the field of technical, educational and economic feasibility of introducing mobile learning in higher education. Next step is the analyzing the capacity and willingness of universities not only implement, but will continue to accompany and develop this area. May be we should hold a series of experiments for testing results and the introduction of mobile learning systems. It is need to organize specialized conferences and workshops for all participants of educational process, with the participation of leading scientists involved in this problem.

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TOPIC 8: mobile learning: yesterday, today and tomorrow

Long Papers

Back to the future: Who cares about the NetGen if mobile technology can help the Matures?

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ABSTRACT

On a daily basis new applications for mobile technology are being developed and released which in turn offer increased mLearning possibilities and support to various groups of people. In South Africa, the rate of adoption of cell phone technology, particularly, is much higher than other stationary types of technologies such as personal computers. Most mobile technology and applications are developed for younger and middle-aged people, as they are the fastest adopters. Unfortunately, this race is leaving the elderly behind. The mature generation needs more support in order to cope with the increasing physical challenges which accompany the process of growing older. With all the benefits that mobile technology presents, it seems reasonable to include this generation in the growing mobile community as they are an integral part of our society. This paper attempts to investigate, by means of a questionnaire, whether mobile technology is being used by the mature generation, as well as how it could potentially be used to support them.

INTRODUCTION

The intention of this research is to determine the needs of elderly people, especially the mature generation, and how these needs could be addressed through mobile technology; it also seeks to identify the short-comings and challenges of mobile technology usage by elderly people. The average human life span is constantly increasing and this has resulted in a growth in the numbers of the elderly. It is therefore necessary to pay some attention to the needs and expectations that this group might have in terms of technology and particularly, mobile technology (Renaud & van Biljon, 2008). According to Renaud and van Biljon (2008) various models have been proposed on technology acceptance from a variety of perspectives, especially in the fields of Information Systems, Human Computer Interaction and Sociology (Gelderblom *et al.*, 2010). The models incorporate factors and phases to predict acceptance and adoption that will lead to persistent use.

Due to the physical, social and mental context of the elderly, models used to determine the behaviour of young adults cannot be generalised with regard to the elderly without further investigation (Wilkowska & Ziefle, 2009, Goodman *et al.*, 2003). According to Carrol *et al.* (2003) the life cycle of mobile phone technology, which includes design, is not clearly understood by elderly users. Research done by Abascal and Civit (2000) indicates that many elderly people do not use their mobile phones to their full potential or they may even reject the technology entirely. Rejection is often the result of the low quality of the interface design or elderly users lacking practical training and experience. Because the technology has been introduced without an in-depth study of the users' needs, this often leads to misconceptions which then produce systems not suited to the target population and are thus rejected. There are still too few examples or guidelines to include the mature generation in the development of technologies (Eisma *et al*, 2003). When user-systems' interfaces are designed with the target population's needs, wishes, likes and interests having been considered, users will adapt and accept the device and the level of misuse will decrease. Moreover, bad designs handicap all users, not only disabled and elderly people (Thimbleby, 1995).

There is a growing need to support elderly people in imaginative and innovative ways, for example through the design, development and use of mobile technology applications and solutions. Research has been done by Goodman *et al.* (2003) to assist the elderly in navigating their travels through using mobile technologies such as hand-held computers. Findings by Goodman *et al.* (2003) conclude that generally available designs and guidelines, often based on studies of younger users, may well not be transferable to applications intended for elderly people. According to Goodman *et al.* (2003) guidelines that are used in designs for elderly people, tend to focus on the desktop domain and do not always transfer well to mobile applications.

The research is guided by the following questions:

To what extent do elderly people in South Africa perceive mobile technology as useful?

To what extent can the research recommend innovative ways of designing and developing mobile technology devices that are able to fulfil the needs of elderly people in a South African context?

In this paper the researchers discuss who may be classified as the mature generation and the elderly and recommend how mobile technology can be designed and developed with a focus on this group. The most important barriers such as physical constraints that play a role in how the devices need to be designed and developed will be considered. In the last section the researchers then present the areas of mobile technology that need further investigation, development, and design for elderly people especially in a South African context.

WHO IS THE MATURE GENERATION?

The Mature Generation is defined by birth dates between 1925 and 1945, placing their ages between 66 and 86 years (Oblinger, D.G. & Oblinger, 2005, Stats Canada, 2009, Dagnino's). Stats Canada defines seniors as aged 65 and over. Stats Canada further makes distinction between the values/attributes held by "younger" seniors - aged 65 to 74 – and those of their counterparts aged 85 and over. There is little, if any, research today exploring the experience (for learning or leisure) of the Mature Generation with regard to information and mobile technology. Yet, seniors are living longer, are better off, more educated and have more internet knowledge and skills than the mature generation before them.

The Baby Boomers generation is defined by birth dates between 1946 and 1964, placing their ages between 47 and 65, and the NetGen generation with birth dates between 1982 and 1991, placing their ages at 20 to 29 years (Oblinger, D.G. & Oblinger, 2005). For the purpose of this paper the researchers will refer to the target population as elderly people. The researchers used an age group including people of ages 52 and over because they will be the next generation of "younger" seniors to use the newly designed improved mobile technology.

MOBILE TECHNOLOGY

The usefulness of common mobile technology, such as mobile phones, handheld computers and digital cameras, stems from their accessibility and portability allowing user access to technologies while on the move (Goodman *et al.*, 2003). The advancement, availability and connectivity of technology all contribute to an increase of its scope and potential. The users can access information more efficiently and in a location of their choice – something that was not possible in the past. The penetration of mobile technologies within the population of South Africa is estimated at 83% (Integrat, 2008). This, therefore, makes mobile technology ideal for providing support in a variety of mobile activities and for a variety of people. These activities include mobile learning possibilities, gaining information about news items, family matters, social matters, transport, holiday trips, medication - and in general improve "anytime, anywhere" communication.

BARRIERS THAT SOME ELDERLY PEOPLE MIGHT EXPERIENCE

The needs and expectations of both disabled and generic users are similar in that each group expects the following from mobile communication services:

- fully reliable communication

- improved service

- safety and quality of life (Abascal & Civit, 2000).

According to Abascal and Civit (2000) the differences are mainly about the level of dependency on the services and the interface design. They further conclude that the requirements that mobile communication systems for disabled and elderly people should meet may be classified under the following categories: personal communication, security, social integration, access to education and the labour market and autonomy.

It is also important to pay attention to the ergonomic limitations of the handsets and to consider that certain sectors of the population are not able to use systems normally designed for all. Therefore the products, applications and services should be designed in such a way that they are open to possible adaptations for specific users' needs. A further area that needs

attention is the learning mechanism (principles) that exist in elderly people. The research will point out some of the needs that were identified through the data collection and analysis.

RESEACH METHODOLOGY

In this section the researchers will discuss the research aim, sampling, data collection and data analysis respectively.

Research aim

The research is guided by the following objectives:

- To establish the extent to which elderly people in South Africa perceive mobile technology as useful

- To what extent the research can recommend innovative ways of designing and developing mobile technology devices that will fulfil the needs of elderly people in a South African context.

Sampling

The research required a diverse sample of at least 41 participants. This is very difficult to achieve using residents of an old-age home or retirement village. Although this context might yield a large enough sample, it is one that is not homogenous in terms of social status and educational background.

The sampling problem was solved by identifying senior staff at the Higher Private Education Institution as 'field workers' and assigning them the task of identifying suitable participants. The participants then had to complete a questionnaire for the field worker. The researchers also handed out questionnaires at some old-age homes in different towns in order to broaden the sample size.

The research design is mainly qualitative and involves a study with 41 participants aged 52 to 88. The questionnaire was used to collect information regarding the participant's general information, needs, interests, whether he/she owns a phone, the purpose of the phone, whether the participant uses the internet and for what reasons and the perceived usefulness of mobile phones and the internet. A combination of guided and open-ended questions was used to collect the data.

Data collection

The research used questionnaires to gather all data. The questionnaires contained both open-ended and guided questions to gather information from the elderly in terms of their general information, personal interests and health status, the adoption of mobile phones and the usage of the internet. The questionnaires allowed the researchers to gather information from a larger group. It also made it possible to gather some quantitative data. It was important to capture information regarding the number of people who own and use mobile technology and the internet to depict the context of the research. However, to capture the participants' impressions and feelings toward mobile phones and the internet and their perceived usefulness, open-ended questions were included. The collected data was then captured in a database which could be used to derive conclusions. The next section will describe how the analysis was carried out.

Data analysis

As previously explained, both quantitative and qualitative data were gathered from the questionnaires. It was therefore necessary to do both quantitative and qualitative analysis. Complete anonymity has been ensured – neither the participants nor the field workers can be identified in the reports.

The analysis was guided firstly by creating the context of the elderly people investigated; secondly, deriving information about the current adoption and usage of mobile technologies; thirdly, attempting to understand the target group's needs and interests and finally, by analysing their perceived usefulness of mobile technology.

Questions that were asked included:

- What are the general social interests and needs of elderly people in South Africa?

- What is the general usefulness of mobile technology and the internet as perceived by elderly people in South Africa?

- To what extent do elderly South Africans use mobile phones?

- Do elderly people in South Africa have access to the internet?

- Do elderly people in South Africa use the internet?

- For what purposes would they like to use mobile technology and internet?

All the above-mentioned questions were answered with the main research aims in mind i.e. to determine and recommend innovative ways of designing mobile technology which might fulfil the needs of the elderly people in the South African context. The following section includes the results of the analysis performed.

RESEARCH FINDINGS

Results

The results indicated the following:

- The youngest respondent's age was 52 and the eldest 88. The average age was 70.

    o 8 were of age 52 – 60

    o 5 were of age 61 – 65

    o 5 were of age 66 – 70

    o 12 were of age 71 – 75

    o 7 were of age 76 – 80

    o 4 were of age 81 - 90

- 85% of the participants own mobile phones. An interesting fact was that 70% of those who own phones, own a Nokia. The researchers cannot explain this phenomenon. Speculated reasons include the following: price (it might be the cheapest), marketing or design.

- Table 1 reflects the main reasons cited for not having a cell phone.

Cell phone Information: Why don't you own a cell phone?
Tone deaf at certain levels, have one on loan from a daughter, used only in travelling
Not interested, have a land line
Use husband's mobile phone
I don't want one
Wife has one
Don't need one

Table 14. Reasons why elderly people do not own a cell phone.

- 50% of those who do not own a mobile phone, said they think it would be easy to use one, while 79% of those who own a mobile phone find it easy to use.

- The percentage of participants *who have access to internet* is 46%, versus 27% *who do not have access to the internet* but who expressed the view that they would like such access. The main reason for not having internet access is that they do not own a computer. The reasons that follow are that they are not interested and that they do not need it.

- Table 2 illustrates cell phone usage by the elderly:

Use	Percentage
Emergencies	18%
Calls	79%
sms	27%
Internet	9%
Banking	3%
MMS	3%
Diary	3%
Meetings	3%
Mapping	3%
Photos	3%
Videos	3%
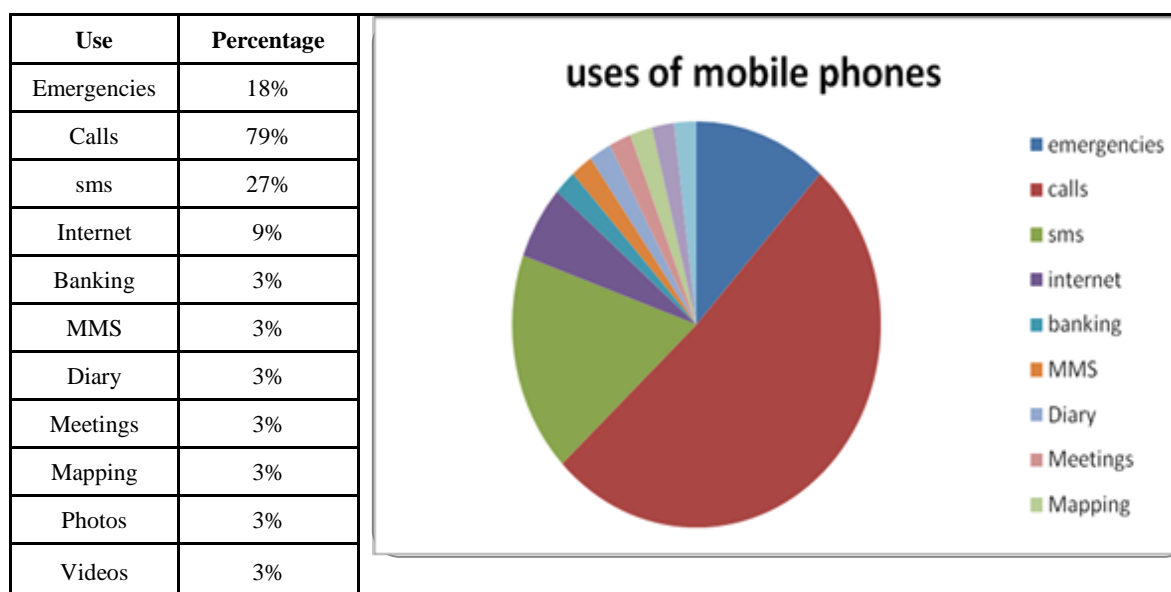
Table 2. Mobile phone usage by the elderly.

- Table 3 illustrates in the first column internet usage by those who have a connection while the second column lists what information those who do not have access to the internet would use it for:

Internet Connection Information	
The user has access to internet	**The user does not have access to internet**
Uses the internet for	**What type of information user would want?**
Own entertainment	Flags
Skype	General information
Communicating with friends far away	Historical information
Information	Just about everything
Bookkeeping	Interests
Travel planning	Health
Everything	Medication
Music	Sport
Search	Cars
Reservations	Vacations
Ministry	General knowledge
Email	Research
Business matters	
Internet banking	
Research	
Friends	
Facebook	
Chat	
Games	
Blog	

News	
Videos	
Sport	
Work	

Table 3. Internet connection usage as perceived by the elderly.

- Table 4 represents the users' perceived easiness of use of the internet.

Do you find it easy to use the internet?	Percentage
I still struggle to remember where to go and what to do but I am still learning	5%
Yes, when taught how to use it	5%
Yes	85%
No	5%

Table 4. Internet connection ease of use as perceived by the elderly.

- The majority do not find the internet expensive and 61% said they would not use an information service.

- Table 5 illustrate the interests of the elderly:

Interests	Average Percentage	Interests	Average Percentage
Movies	48.8%	Music	51.25%
Nature	37.8%	Cooking	23.2%
News	78.05%	Travel	41.45%
Sport	54.85%	Anything	19.5%
Stories	31.7%		

Table 5. Interests of the elderly.

Discussion

As previously discussed, there are indicators that many elderly people do not use their mobile phones to their full potential or they may even reject the technology. There is a significant number of respondents who do not exhibit the characteristics of either rejection or acceptance but who do see the possibility of mobile technology helping them in their daily lives.

Our results lead to the following conclusions to each of the research objectives:

To what extent do elderly people in South Africa perceive mobile technology as useful?

According to the researchers' results, elderly mobile technology users are divided into 15% who do not own a mobile phone versus the 85% who do. Half of the elderly people who do not own a mobile phone perceive it to be useful, while the remainder do not. At least 79% of the elderly people who own a phone find it easy to use. The majority of elderly people use their mobile phones only for calls, sms messages and emergencies.

According to the researchers' results, 46% of elderly people access the internet and find it very useful for a number of reasons as listed above. Some of the remaining 54% who do not have internet express a number of needs and interests they would like to access should they have internet. Some of the reasons for not having access include affordability, no computers, no need or no interest.

To what extent can the research recommend innovative ways of designing and developing mobile technology devices that are able to fulfil the needs of elderly people in a South African context?

According to the researchers' results it is recommended that when designing and developing mobile technology applications, attention should be paid to:

- Enlarging the size of the screens and visibility of content, given the fact that 34% (14 participants) experience eyesight problems;

- Improving the decibel frequency of sound as 20% of the participants experience hearing problems;

- Designing GPS applications for mobile technology to accommodate eyesight, memory and hearing problems. A large percentage of the participants (88%) own a car and 90% are still fit to drive – they are therefore able to travel around and might find such applications useful;

- Developing mobile technologies for elderly people which should focus on expressed needs such as gardening, needlework, baking, cooking, travelling, sports and news.

Based on our results the researchers therefore conclude that although elderly people in South Africa have adopted mobile technology, they have not explored the full capacity and capabilities of this technology. Therefore more attention needs to be paid to raise awareness among elderly people to adopt mobile technology more fully. There is a need for mobile technology devices to be designed for elderly people, which will be useful and which they will be able to be use.

CONCLUSIONS

The researchers explored the needs of elderly people in South Africa and their use of mobile phone technology in an attempt to better understand this user group's perceptions towards technology.

It has been established that there is a need for access to more information by the elderly through the use of technology given the fact that they are still mobile and need the information when travelling. Mobile technology might be more accessible than the stationary type of technologies such as personal computers. It might also improve the autonomy and self-confidence of elderly people.

Our findings suggest a correlation between the variables of age and whether these participants own a phone; however, the possible correlation between how the phone is used and their needs is interesting and indicates a need for further research. A similar study is being conducted in Canada so the researchers will be able - at a later stage - to compare the findings of this paper with studies based on elderly users outside South Africa.

Mobile technology can improve the quality of life for elderly people, but only if the design, interface and development of such devices are perceived and experienced by elderly people as useful and usable.

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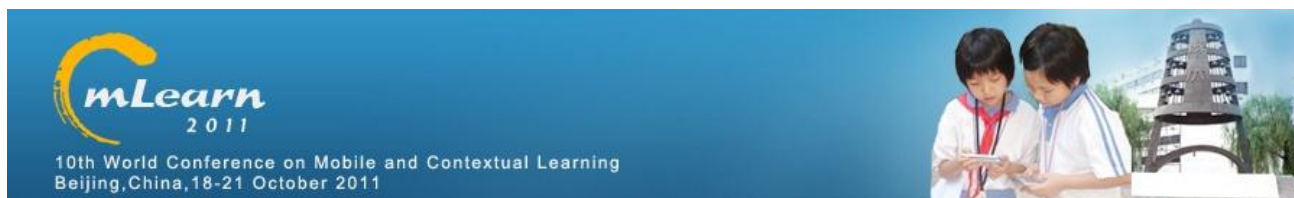
Flexible learning with flexible devices: opening up opportunities

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ABSTRACT

This paper reports on an action research study of students' exploration and use of previously unexplored low-spec sub US$100 open-source mobile devices for learning programming. The study was conducted over a period of fourteen weeks in University of West London, UK with the postgraduate students studying Mobile Application Development (MAD) module which is a part of the MSc Network and Mobile Computing course. We introduced the Wikireader, a handheld reading device and Nanonote, a lightweight pocket computer, developed using a copyleft approach. In this study, we used mixed methods research methodology. Data analysis was guided by the Framework for the Rational Analysis of Mobile Education (FRAME) model. From the results of our evaluations, we were not able to ascertain whether or not these devices improved learning programming. However, the findings indicate these open-source devices have potential to enhance motivation to learn programming without being restricted to the limited practical sessions in the university lab and also facilitate offline reading.

Author Keywords

Copyleft Hardware, Offline Mobile Learning, Nanonote, Wikireader, Open-source Technology, Mobile Usability.

INTRODUCTION

Learning programming is not easy and there is no shortcut in learning to program (Hassinen & M äyr ä2006; Sheard et al. 2009). Generally, the learning approach is based around lectures on specific topics, followed by tutorial / practical sessions on applying the lecture content to specific case studies. "Programming language concepts are highly logical and therefore difficult to understand by conventional study materials" (Patil & Sawant 2010). Even though the traditional approach of concepts first is common, students struggle to learn program due to lack of extensive hands-on practice and sufficient time to become familiar with programming concept.   Therefore, a clearer approach to teaching programming is needed (Milne & Rowe 2002) and research has shown a learner-centred approach to teaching programming is effective and successful (Moura 2011).

In this exploratory pilot study, our focus is on the low-spec sub US$100 open-source handheld mobile devices. As the cost of hardware reduces we are beginning to reach a point where it will become possible to replace a USB flash storage device in your pocket with a small computer. This style of ubiquitous computing provides some interesting learning opportunities but also poses significant technical and usability challenges.

This paper reports on an empirical study of the deployment of Nanonote and Wikireader for learning programming with the group of twelve students studying MSc Mobile and Networking.   Our aim was to evaluate the usefulness of devices in

teaching and learning by assessing its usability, probing how students used such devices and identifying problems while learning programming and provide support throughout the study period.

We begin by reviewing the context of programming education and benefits of introducing mobile devices to support learning. Then, we highlight the open-source copyleft approach, possible benefits of such approach to software and hardware designs and introduce the Wikireader and Nanonote devices. Next, we discuss the research methodology and elaborate on the research approach we used in this pilot study. Finally, based on the FRAME model for mobile learning, we analyse our findings and conclude by reflecting on our results and the overall study.

LEARNING PROGRAMMING USING MOBILE DEVICES

"Mobile application development requires a considerably different approach compared to applications for the desktop computers and need the understanding of the complexity of their operating environment, which is much less predictable than contemporary fixed wire networks, and the restrictions placed by the devices themselves in terms of memory, power, speed, screen size, etc" (Edwards & Coulton 2007). Therefore, it is important to encourage students to gain practical skills to develop applications with the understanding of the existing limitations of the mobile platforms that a developer faces daily. Introducing mobile devices at an early stage in the computer science curriculum can improve students' learning (Mahmoud & Popowicz 2010) as a use of hands-on oriented approach in introductory programming courses has shown increase in a positive experience (Kulkarni 2010; Richards & Smith 2010).

Bruhn and Burton (2003) studied the use of computers in the classroom to help students to better understand programming concepts during classroom presentations. Even though this approach helped the average-to-poor students' achievers the most, it needs more time to present the material to the students and it also takes time for students to practice programming concepts on the computer in class. Research shows that only through adequate practice and training can expertise be obtained in the field of programming (Bruhn & Burton 2003; Ala-Mutka 2004) and thus learning should go beyond classroom/lab environment.

Some of the proposed approaches to teaching computer programming are using robotics or through the use of game design and using mobile devices (Mahmoud & Popowicz 2010). Introduction of mobile devices in programming education provides the practical development experience students need and students appreciate the unique opportunities mobile devices offer and also become aware of the development challenges they present (Mahmoud & Dyer 2008;Mahmoud & Popowicz 2010). However, the analysis of research papers about programming education published in computing education conferences identified only few studies that considered online distributed or mobile learning in programming education (Sheard et al. 2009). Therefore, we approached teaching programming by using mobile devices to provide relevant programming knowledge and these devices can also be used for hands-on practices. At the time of this review, we were not aware of research studies that explored open-source platforms particularly the Nanonotes and Wikireaders in such programming education context.

COPYLEFT APPROACH

Mobile technology is developing and mobile phones capability and performance is continuously getting better. Now, there are many different devices with different screen resolutions running on different platforms and platforms have been proprietary and scattered. There are a variety of operating systems such as Symbian OS, Microsoft's Windows Mobile, Linux, iPhone OS and many other proprietary operating systems. According to Hashimi and Komatineni (2009), supporting standards and publishing APIs would greatly encourage widespread, low-cost development of mobile applications, but none of these OSs have taken a clear lead in doing so. Therefore, the need to support open standards to encourage interoperability of emerging technical solutions is one of the grand challenges (Dearden et al. 2010).

The emergence of "app stores" provide a platform where small applications are exchanged for small amounts of money without any requirement to share code.   We believe in an approach which encourages sharing of knowledge and therefore believe in using mechanisms such as copyright law to enforce this approach. The approach is known as "copyleft".

Open-source copyleft platforms are relatively new but have a promising future. Copyleft license guarantees every user has freedom and anyone who redistributes the software and hardware design, with or without changes, must pass along the freedom to further copy and change it. According to GNU, "the"left" in "copyleft" is not a reference to the verb 'to leave'—only to the direction which is the inverse of 'right'". As the restricted license of a proprietary devices do not allow using hardware designs freely, the copyleft approach however ensures the design is always open for a complete customization, enhancement or extension, allowing the community to influence its future hardware revisions and there is no end of life for devices as in a proprietary system. If copyleft approach used, even if the device fails, it can at least ensure that the design can continue to live and be improved in future.

We believe solutions that use a copyleft approach not only give freedom to the software developer, they also provide an opportunity for the community to directly influence the hardware roadmap of a device and thus generate possibilities for creating new and sustainable solutions within specific markets.

The sub US$100 WikiReader (see Figure 1a), by Openmoko, offers an interesting alternative to the phone for supporting mobile learning. The Wikireader is a non-wired mobile device. Its software platform is open source and freely available. Initially, it provides the content of Wikipedia (an electronic encyclopaedia), which can now be updated to display in eighteen different languages. It allows the software developer to customize or adapt the software and contents as necessary. Another promising sub US$100 open copyleft hardware device is the Nanonote (see Figure 1b) by Qi Hardware. It is an ultra small form factor computing device with 3.0" color TFT display. It runs embedded Linux distribution (OpenWrt, which is usually found in Wifi routers) and uses a kernel, bootloader and root file system that can be flashed over the USB port. The device is however still in its infancy and does not have a built-in wireless capability. The device is not designed to be mass marketed consumer electronic product and at the moment, it is targeted at developers, so that it can be turned into something useful as necessary.

While benefits of open-source software are well established, consumer hardware based on an open-source copyleft designs are yet to be seen. Weiss (2008) highlighted, "as it has happened with open source software, though, it may take some years and test cases for legal clarity to emerge in open source hardware". Therefore, there are also several challenging questions that open source hardware faces such as how would business benefit from open sourcing hardware and who is really going to make their own device? (Weiss 2008)

Figure 1a.Wikireader – offline handheld reading device. Figure 1b. Ben Nanonote - an ultra small form factor copyleft computing device which has 336 MHz XBurst CPU, 3.0" display and 2GB NAND flash memory.

RESEARCH METHODOLOGY

In this study, we took an action research approach. The basic premises of an action research paradigm are that the research is "participative, grounded in experience, and action-oriented" (Reason and Burgess, 2001 p.xxiv in Lunsford 2010). The students' participation helped not only to evaluate the devices but also to understand the problems they faced while learning

programming and provide the necessary support during the study. Similar to Lunsford research work at the Open University (Lunsford 2010),   the goal was also to disseminate the findings within the University for the wider use of other staffs and students that could lead to possible changes in practice.

For the evaluation purpose, selection of the research methods for this study was based on earlier studies of adoption of mobile technology for learning by Corlett et al. (2005) and Waycott (2004). To capture the unique elements of the participants' experience, where possible, flexibility was built into the study by not committing to a particular route and regularly reviewing possible approaches to data collection (Dearnley & Walker 2009). From the fields of Mobile Human Computer Interaction and Mobile Design research (M-HCI/D), this research employed mixed research methodology, which is the most common approach used in programming education research (Sheard et al. 2009), to gather and analyze quantitative and qualitative data on mobile learning and usability. Due to exploratory nature of this research, data analysis was iterative and reflective process throughout the study. The data was examined in relation to the Framework for the Rational Analysis of Mobile Education (FRAME) model, which is discussed next.

Framework for the Rational Analysis of Mobile Education (FRAME) model

Research shows the lack of specific models for teaching and learning of programming and research studies that investigated learning within a theoretical framework to explore the process of learning (Sheard et al. 2009), which is important to deepen our understanding of students' behavioural or affective responses to their learning or teaching experience. We adopted the Framework for the Rational Analysis of Mobile Education (FRAME) model (Koole 2009) to study the feasibility of open-source platforms for teaching and learning programming.

"The FRAME model describes mobile learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction" (Koole 2009; Koole & Ally 2006). There are set of three intersecting circles representing the device (D) which describes characteristics unique to electronic, networked mobile technologies; learner (L) describes characteristics of individual learners; and social (S) aspects describes the mechanisms of interaction among individuals (Koole & Ally 2006).

The overlapping intersection of the FRAME model representing the device usability (DL) and social technology (DS) describe the affordances of mobile technology; the interaction learning (LS) contains instructional and learning theories and the primary intersection (DLS) in the centre is a convergence of all three aspects, defines an ideal mobile learning situation (Koole 2009). As we were introducing a new technology, the main focus of our pilot study was in the device (D) and the learner (L) aspects and its intersection device usability (DL).

The low-spec Wikireader and Nanonote devices are not equipped with various technical capabilities, such as short messaging service (SMS), telephony, and access to the Internet through wireless networks. Therefore, these devices do not enable active communication between the students and tutor. Nevertheless, we wanted to maintain the existing culture of physical and virtual cooperation and communication between students' and tutor in the classroom, lab and through Blackboard virtual learning environment and facilitate learning by introducing these devices (Koole 2009). Students were also encouraged to engage in problem solving activities and where possible exchange knowledge and collaborate. It is however important to fully explore the social technology and interaction aspects of using mobile devices which are important to fully utilize the affordances of the devices especially in the context of mobile distance education and blended learning (Kenny et al. 2009).

PILOT STUDY: BACKGROUND

The pilot study was carried out in University of West London with a small group of twelve full-time students studying Mobile Application Development (MAD) module which is a part of the MSc Network and Mobile Computing course. This module has been developed to provide hands-on experience developing software for mobile devices using an open source approach to software development and students are expected to gain experience using relevant industry standard tools to

support their work. The organization of this study and the data collection was completed in four months starting September 2010.

The Module: Mobile Application Development (MAD)

The MAD module is delivered over the period of fourteen weeks and provides three hours of class contact per week. One hour for a formal lecture and two hours of practical lab classes. There are two parts in this module. First seven weeks focus on the use of C Programming language and in the other half; students use the higher-level programming language building on the experience from what they learned from the first seven weeks.

To pass this module, students are required to submit two assignments in seventh and the fourteenth week which is the end of the term. Both assignments have one element each which required developing a command-line application that is capable of communicating structured binary data across a TCP/IP network and suitable for deployment on a Linux based embedded device. As it is important to gain some experience designing and structuring binary network protocols, students are introduced to the Packedobjects - a data encoding tool that provides high-level bit-packing on low-level devices (Moore 2010).

Study Approach

The first part of the module was taught using combination of lecture and practical class where students had hands-on experience of programming in the lab. But on the second part of the module, they were also given Nanonote and Wikireader devices to take away and use until the end of the term. The students were not trained specifically to use these devices, as they were expected to explore and use the devices to support learning programming.

At the beginning, we obtained the written informed consents from the students who agreed to participate in this study and administrated the pre-questionnaires and analysed the demographics. Then students randomly selected the devices, so that the six students had Wikireaders and other six had Nanonotes. As prerequisite, the students were expected to be familiar with some programming and Linux desktop environment and where available, they were also encouraged to setup Linux system in their personal machines.

As the students were studying other two modules as part of the MSc course and busy with assignments, we realized the data collection techniques have to be simple and this study should not be felt as a burden to them instead of our goal of providing support for learning. Therefore, even though we initially planned to use the diary study method, students were requested to keep the log of their activities instead. Research shows that diary study method can suffer from the drawback of potentially missing data, because participants may forget to record entries or are selective in reporting (Bolger & Davis 2003), and also possible that they may find it difficult to write unprompted (Hall 2008). In the activity log, students simply recorded *when? where? why?* they used the devices and documented if they found them useful and also record the problems or difficulties they faced. The simple log provided an effective way to monitor progress and also identify learning issues early and provide appropriate support.

Finally, post-test questionnaire at the end of the study was used to find out what features of the device the students had used and whether they had found it to be a useful tool for supporting learning and what the benefits and limitations of the technologies were. The activity logs were also used in a supplementary manner which helped to further understand the students' view that they expressed in the post-test questionnaires.

DEVICE ASPECT (D)

According to Kenny et al (2009) mobile learning is constrained by the mobile device hardware and software configurations and dependent upon adjustments in teaching and learning strategies. While benefit of mobile learning is clear, developing sustainable solution is still a challenge, as the mobile industry is dominated by proprietary technologies and this situation is mirrored throughout academia (Shrestha et al. 2010). Therefore, even though the use of the latest mobile technologies can have significant impact on teaching and learning, assessment of the technology platform for the long term is important to sustain the solutions.

Ownership of the technology is equally important in mobile learning (Corlett et al. 2005; Traxler 2010). But, mobile learning approach cantered on student devices is challenging as well. "From a methodological perspective it is easier with a homogeneous technology platform and also easier from a staffing and infrastructure perspective but such solutions are unsustainable because they are predicated on finance in order to provide devices" (Traxler 2010). From a developer's perspective, creating solutions for a locked-down device restricts creative and innovative development as well (Moore et al. 2009).

The selection of the open-source mobile platforms (Nanonote and Wikireader) for this study was based on the requirement of this module which is to enhance students' understanding of the limitations and constraints when writing software for embedded devices. We needed mobile devices that were comparatively cheaper (sub US$100), freely customizable and portable that students could use anytime anywhere without incurring extra cost. The use of such cost-effective open-source platforms support creativity and provide freedom and unlimited choices for students. We believe that the chosen platform may allow us to move our pilot to the mainstream of educational provision and finding secure and sustainable funding and support (Traxler & Leach 2006).

Preparation of Devices

The university has a Windows based network and there is no dedicated lab for Mobile and Networking students. However, in one of our lab, we setup each computer with a dual boot Ubuntu and Windows operating systems. In the existing system, university does not allow students to install necessary open-source software. Therefore, by introducing these mobile devices, we were hoping to relax such constrains and provide total freedom for students to practice programming in the university and also outside the institutional contexts.

The Nanonote devices were customised to support the necessary software to provide hands on experience of packing data and communicating it across different kinds of hardware. Setting up devices was a non trivial task, but worked well after careful preparation. Due to the specialised nature of the module, students were also free to customise their devices, such as changing the default distribution and adding multimedia content. The device related and available software are well documented and freely available online.

The Nanonotes were configured with lightweight Jlime Muffinman Linux distribution which has been built using OpenEmbedded with Jlime look and feel. It included already configured several useful stripped-down versions of applications to supplement it and also a complete software repository. The current image provided a X Environment, Matchbox window and desktop manager, and several useful applications such as video player, music player, image viewer, text editor, terminal, PDF viewer, dictionary and games. The devices were then loaded with necessary PDF manuals.

The Wikireader devices were also customised to provide access to necessary resources. Initially, the plan was to setup a course wiki based on the university's virtual learning environment (VLE), so that the lecturer can create and edit articles, but anyone can read those articles and leave comments. But, to customise the Wikireaders, we needed to upload the content from the course wiki to the device, which required importing an XML dump to be compiled and copied to micro-SD cards. Due to lack of flexibility of the existing VLE, we had to setup a new Wiki site using an open-source Mediawiki of which we had a full control. The site was setup in such a way that only the lecturer could edit the pages. Then, Wikireaders were customised to provide an offline access to Packedobjects manual and also imported freely available English Wikibooks, Wikiquotes, Wikidictionary and a full Wikipedia.

LEARNER ASPECT (L)

Our Masters programmes attract overseas students, mainly from India. These students can have difficulties adapting to a UK university learning environment. Some of them also have limited access to ICT resources outside the university. Previously, we have also experienced students' inability to make a significant improvement in MAD module due to lack of programming skills and unfortunately many dropouts or change their course pathway where programming is not

compulsory. While those who decide to do this module, many struggle as they often fail to recognize their own deficiencies.

In this pilot study, all the students were male and were below 25, except for one student with age range 26 – 35. All the twelve students had regular access to desktop computer with Internet at home or university lab and library and good experience of using them for personal, work and study purposes. They also owned variety of mid-range to high-end mobile phones. 83% of students had post-paid (contract) phone but only 33% students had data usage plan. Most of the students were concerned about the cost of using mobile internet. Some of them did not need to use mobile phone for browsing as desktop use was sufficient for them and when available, some students preferred desktop computer to mobile device for accessing the internet.

Previously, none of the students had seen or used these relatively new Nanonote and Wikireader devices. However, they were enthusiastic and showed interest in participating in this pilot study as they thought it would be useful to have an access to resources offline to support their study and also use for hands-on experience.

DEVICE USABILITY (DL)

While Wikireader is a dedicated offline text reading device, Nanonote is a general purpose Linux computer. This study is therefore not a comparison between these two different devices but instead their evaluation for the purpose of mobile learning.

Wikireader

All the students said they used the Wikireader a few days a week to read and used it at home and while travelling as well. Out of 6, 5 of the students found it very useful for reading, while only 1 student found it somewhat useful. Most of the students found Wikireader easy to use. The most important advantage that students highlighted was the readily available content without using Internet in the portable, handheld and easy to use Wikireader device that supported uninterrupted reading at home or at work and also while   travelling. As one of the student described the benefits: "*easy learning process, can be used anytime, anywhere, easy to carry in the pocket, no need of internet, low cost and very fast access to useful information*".

However some of the concerns were the difficulty to search long phrases, sometimes not getting results as expected, having to go back to 'home' while navigating through the text, poor screen resolution, not knowing how to adjust backlight and not being able to read on nights. More than half of the students found onscreen keyboard neither easy nor difficult to use, while 2 students found somewhat difficult to type as they found touch screen unsmooth.

All the students found the 'Search' and the 'History' functions very useful and easy to use. But only 2 students found the 'Random' function useful, while 1 student found somewhat useful and 2 students never used this feature. Only 2 students used the device for reading other than the Packedobjects software manual. They found dictionary and quotes particularly useful.

While the low-spec Wikireader was easier to use and read texts, students did not attempt to update the device with their own content as there is no automatic synchronisation or straight forward updating mechanism. For newer content, the device software needs to be recompiled with XML dump and copied to the MicroSD card. A further research is needed to develop a tool to facilitate this process so that a common user can also customise the device easily. Therefore, we encouraged students to explore the open-source platform to appreciate its benefits to full potential.

Nanonote

In our study, 4 of the students used the device a few days week, while the other 2 students used only once a week. They used the device mostly at home and 2 students used while travelling as well.

Half of the students said reading on Nanonote was rather easy and the other students found somewhat difficult. They found reading PDF on the Nanonote was difficult due to small (3" size) screen and the difficulty to use the compact 59-key

keyboard which had a considerable impact on the ease with which students could navigate through text. Even though students found thumb typing on the Keyboard convenient, they felt it was slow due to its layout and the small keyboard buttons and therefore said it needs more practice.

Even though some of the students found the Nanonote useful for reading PDF documents, they felt a steep learning curve to use the device and the software. In general, using the device required remembering functions of certain keys or combination keys. Reading PDF documents required extensive scrolling both horizontally and vertically and also needed to remember different keys configured to start and close the application, zoom in and out while reading the document and to go to different pages.

However, beyond reading documents, one of the students also found Nanonote very useful for listening mp3 audio and watching videos while travelling. A student compressed the video using freely available software and copied to the device. While all the students appreciated the use of Nanonote to understand and learn the programming for embedded devices, only a couple of students attempted to flash the device with the minimal OpenWrt image containing GNU Guile built by the tutor and used for testing the command-line software they developed as part of the second assignment. As they had an unlimited access and control of this device, students were able to install and remove software, customise as necessary which they could not do in the lab computer. However, it is likely that prior instruction in their use will be needed as most of the students felt customising Nanonote will be somewhat tedious for the novice Linux users.

Analysis of Activity Logs

Regardless of lack of Wireless connectivity, all the students said that they used Wikireader both at home and while travelling, but Nanonotes were used mostly at home. From the activity logs, we found 60% of the usage of the devices was at Home and 40% was while travelling. They used both devices from few minutes to half an hour and up to maximum one hour. While using Wikireaders, all the students said that they sometime made notes on paper but only two users made notes on the paper while using the Nanonote.

The analysis of log shows, results of the 70% of the activities on Nanonote devices were useful, 10% of the results were somewhat useful and 20% of the results were not useful. On Wikireader device, students found the results of the 77% of the activities useful, 9% of the results somewhat useful and only 14% of the results were not useful.

From the log we were also able to quantify the number of problems students encountered while using these devices and the result supported the views students expressed in the post-test questionnaire. It shows that students encountered 60% of the usability problems and 40% were the technical problems while using the Nanonote devices. They faced technical problems such as difficulty in setting up DNS forwarding, difficulty in installing the tools needed on the desktop, which were solved with tutor's support in the lab. But it shows there were significant usability related issues especially the difficulties of using the software, the small keyboard and navigational issues while reading the content.

Wikireader users noted 28% of the technical problems related to typing especially long phrases on the touch-screen and 72% of usability issues were related to adjusting backlight, sleep mode and navigating using back button. Some of the activities were also related to searching for information unrelated to the course and students found unsatisfactory or limited results.

Portability: Even though these devices are small enough to fit into pocket and easy to keep it safe and secure physically, one of the students lost the Nanonote in the last week of the pilot study.

Assignment Results

We noticed the differences in the average results for the two assignments (A1 and A2) comparatively (see Figure 2). In the first assignment, students achieved average 56.66% and for the second assignment they achieved average 61.83%. Overall, the average mark for the mobile application development module was 61.83%. However, three students actually achieved less mark in the second assignment than in the first assignment and in aggregate, two of the students could not achieve minimum 50% required to pass the module and therefore needed to re-sit.
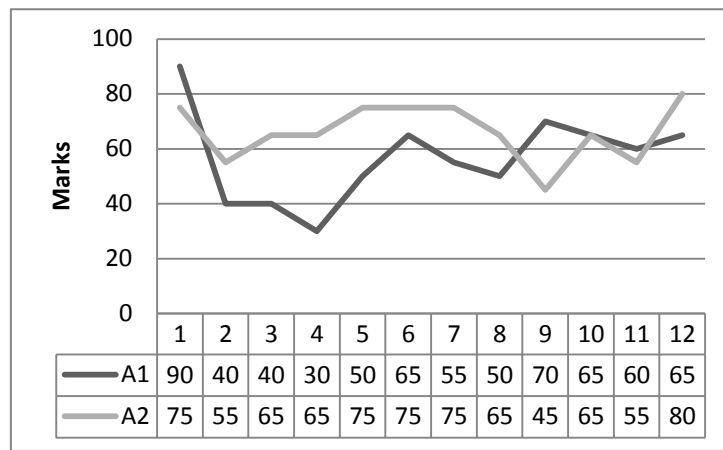
Figure 2. The comparison of marks for the two assignments (A1 and A2).

	1	2	3	4	5	6	7	8	9	10	11	12
A1	90	40	40	30	50	65	55	50	70	65	60	65
A2	75	55	65	65	75	75	75	65	45	65	55	80

LIMITATIONS

The aim of this study was not to identify and measure the impact on learning embedded programming and also not meant for generalising our findings to a larger population due to small number of students participation in a short period of the study. Therefore, the findings of this study should be used with caution to inform other programming education related studies. As this study mainly focused on the device usage, the results provide indications on students' perceptions towards the effectiveness of open-source platforms for student support and the findings could also be useful to support the adoption of offline mobile learning model to provide an access to resources and support learning.

CONCLUSION

In this paper, we reported an exploratory evaluation study of relatively low-cost / low-spec research-oriented open-source mobile devices to teach embedded programming. It has helped us to identify the benefits and limitations of the Wikireader and Nanonote devices by exploring how students perceived and used these devices, and how well they believed these devices supported their learning activities. This has demonstrated the feasibility of a hands-on approach that can be used to improve the further use of such devices in teaching programming.

In this study, the Nanonotes and Wikireaders were perceived by the students to be an effective tool in support and learn embedded programming. An access to these mobile devices provided opportunities for students to use the devices throughout the term for learning. Students found Nanonote device useful for practicing hands-on programming for embedded device than general reading purposes. While Wikireader device can also be customised, students found it more suitable for uninterrupted anytime anywhere offline reading. Students were not concerned about the lack of wireless Internet access, as the devices were provided with required resources for the specific subject they were studying. Therefore, this study recommends further explorations of the potential of affordable open-source platforms to develop an effective and sustainable offline mobile learning solution to provide ready access to resources and supporting teaching and learning embedded programming.

This study also highlighted that to take a full advantage of devices as such and to progress quickly, students must be supported in the early stages and their usefulness must be visible to them at the beginning. As the students are usually under pressure to complete assignments and prepare exams for different modules, they are unlikely to invest valuable time learning the devices so that they could possibly use for supporting the study. It is crucial to identify and provide the useful resources that students really need and align the use of the devices with the requirements of the module to enhance the learning experience by exploiting the potential added value these devices could bring.

Similar to Kenny et al (2009) findings, guided by Koole's FRAME model (Koole 2009) of m-learning, we also found "access to and usability of mobile learning devices is critical to supporting the context of learning and learning interactions". Therefore, even though open-source platforms provide the greater flexibility and freedom that can be leveraged to shape the

design of future cost-effective and sustainable mobile learning solutions that students really need, it is also important to provide a satisfactory user experience at the same level or else effectiveness of using such devices cannot be realised and the solution is more likely to fail.

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Fuzzy Proximity Estimation with Opportunistic Use of Wi-Fi and GSM Fingerprints

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ABSTRACT

Lack of communication is often the major problem during emergency situations in large or small crowds in indoor environments. The scope of this project is to tackle this problem by keeping in touch with people and guide them through the emergency. This will be done by implementing a Fingerprint Match Algorithm which will detect the location of all users in the indoor environment through their mobile device. With all the locations, group formations can be estimated, so each group could be directed to safety by sending the people of each group messages with directions depending on location.

Author Keywords

Localisation, Wifi, GSM fingerprint,

INTRODUCTION AND BACKGROUND

Lack of communication is a major factor in crowd management during emergencies [1]. It can lead to fatalities as people at the back of a crowd will push on the people at the front which results in those at the front being crushed [1]. Knowing the type and location of the emergency is not enough. To inform people and guide them through the emergency their behaviour at that moment needs to be known. Therefore, context information, like each person's location and proximity to others, needs to be extracted [1]. To obtain context information in indoor locations, sensors need to be worn by everyone to collect information about the user and the environment in which he is currently in [1]. But how people can be obliged to carry with them sensors? The answer to this is mobile technology. Mobile devices are very much context aware.

Context Awareness

The idea of context awareness is a very important concept. It is the sensing of the environment to extract important information that can be used by a particular user [2]. Context awareness is a concept long been studied in computer science to be able to develop context aware applications [2]. It has been a central figure in natural language processing and human computer interactions to adapt interfaces according to the context the user is currently experiencing. The notion of context is defined in [2] as *"that which surrounds and gives meaning to something else"*.

Abowd et al [3] also defined the parts of context information that can be gathered from the user from a context aware application. These are also known as the *"five W's"* [3] [4]:

- Who? – Who is the user and who are those near him? (Identity)
- What? – What the user is doing? (Action)
- Where? – Where is the user? (Location)
- When? – When this is happening? (Time)
- Why? – Why the user is doing what he is doing?

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The last part is derived from the previous four parts which can be extracted from the environment. With this information extracted context aware applications can be built. *Abowd et al* [3] give the following definition for context aware application as *"A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task"* [3]. This means that context aware applications need to extract some of the above parts of context to adapt to the user requirements or provide a service to the user. An example of a context aware application is Active Badge [5]. Next sections will deal with *Where* and *Who* parts of context information that can be extracted from the environment that is localisation to obtain location and proximity to others.

Localisation

Localisation is an important factor in context awareness as obtaining location will provide further context information [2] [3]. Localisation is the locating of an object's location anywhere on the planet [6] [7]. Position is the building block of a location [7]. The position consists in the form of coordinates that can be represented in three different ways:

- Absolute coordinates – These coordinates include the Latitude, Longitude and Elevation. They are the universally accepted way to define a location [7] [4].
- Relative coordinates – In relative coordinates an x and y values are used to describe the location from a fixed reference point. For example in graphs where the x and y coordinates are from the origin [4].
- Symbolic form – This type of location representation describes a location directly. For example "Room 1" or "Computer Lab in the ICT Faculty" [4].

Mobile localisation is the locating of a mobile phone's approximate location, anywhere depending on certain parameters obtained from sensors that give information about the environment [8] [9] [10]. These sensors in question are the wireless technologies that are found on mobile phones [8] [7]. GPS technology is used for outdoor localisation while GSM fingerprints and Wi-Fi signals are more suitable for indoor localisation since GPS signals cannot be reached inside buildings [8]. In other words our mobile phone knows where we are [7].

To discover the current location using GSM and Wi-Fi signals different techniques can be used such as Fingerprinting. Fingerprinting is a very simple technique which is based on measurements captured at a particular location [8] [4]. This technique consists of maintaining a database that holds different measurements at different locations which are known as *fingerprints* [8]. These fingerprints can consist of different types ranging from sound [11] to radio signals [4]. Fingerprinting is very useful in indoor environments where location can be estimated without knowing the exact physical location. Location in this case is in symbolic form. The database is built during the training phase by recording a number of measurements and their respective locations to build the radio map of the building from the inside and then applies this using a mathematical model to recognise an unrecorded measurement which is the best match to the fingerprints present in the database [8] [4]. The fundamental advantage of fingerprinting is the fact that it takes into account the effect of the structures and people in the indoor environment since the signal strengths at locations remain constant through time [8].

With the location obtained, Location Based Services (LBS) can be provided to the user. LBS are services provided to a mobile user based on the current location he is in. With the rise of mobile phones and their ability to connect to the internet on the move increased, location based services increased the amount of opportunities for users to have services depending on their location [7] [10]. The biggest advantage is that a user does not have to enter the details of the location he is in to obtain information depending on his location. He might even be unaware of his location and it is automatically detected [9] [10].

Proximity

Proximity depends mainly on the behaviour patterns of a crowd at a particular moment. Collective behaviour patterns are complex patterns to recognize in crowds [1]. Therefore they need to be decomposed into a set of primitives so that to be able to reason about crowds. These primitives are called the collective behaviour building blocks. Some of these primitives include *dispersion* and *aggregation* [1]. To conclude these primitives we need an individual personal characteristic that is

characteristics of an individual person in a crowd like heading, speed etc and also crowd characteristics such as dimension and density [1].

AIMS AND OBJECTIVES

The aim of this project is to use LBS concepts to build a test system which detect users' locations in a small indoor environment, detects group formations for sending of information to groups and to have group structures information during emergency situations. With this information groups could be directed on what to do during emergencies like for example to reach another exit, avoid certain areas or go to a safe place until rescuers arrive. This will help to keep in touch with people and therefore reduce the problem of people at the back crushing over people in front as mentioned earlier. To achieve this aim the following objectives need to be fulfilled:

i. Make use of machine learning to implement a fingerprint match algorithm that will use signals that can be reached indoors like GSM and Wi-Fi signals and estimate the current location.

ii. The development of an application that provides a location based service to the user by adapting to the current location and gives the user information about that location.

iii. Detect proximity to other people nearby using the locations found from each mobile device.

SPECIFICATION AND DESIGN

This project is based on two basic concepts:

- Localisation – To find a mobile's device position in an indoor environment.
- Proximity – With localisation of the mobile device, proximity to other users could be estimated by comparing locations.

For localisation the fingerprinting technique will be used since GPS is not available indoors. To describe a location, symbolic form will be used. In this way each location can be described symbolically by giving it a name and a description. Then a location can be associated to a set of fingerprints that describes it. Fingerprints can be acquired by reading the Cell ID and RSSI of the cell currently connected to and the six nearest cells, and by reading the SSID, BSSID and RSSI of all Wi-Fi access points from various predefined locations. These need to be maintained in a database. So a Fingerprint Match algorithm needs to be developed that will use these fingerprints to compare them with unknown ones to estimate the current location. This Fingerprint Match algorithm will be implemented using the K-NN machine learning technique [12].

Data Representation

How data will be represented is a fundamental aspect in this system, as it will affect the functionality of the algorithm. A fingerprint will be described with the relationship (RSSI, ID), where RSSI is the value measured from a source, and ID is the ID of that source. If the source is a GSM cell, the Cell ID will be used as the ID of the fingerprint. Else, if it is a Wi-Fi source, the BSSID would be used. With this definition of a fingerprint a set of fingerprints can now be defined as:

$$F = \{(RSSI, ID) | RSSI \in \mathbb{N} \wedge ID \in S\}$$

Where S is the set of all IDs measured when collecting training examples. For a particular location only a subset of fingerprints can be measured. Therefore a measurement relationship needs to be established between the location and the set of fingerprints that define it. A measurement will be defined as the relationship (Location, fingerprints). Therefore a set of measurements will be defined as:

$$M = \{(Location, f) | Location \in L \wedge f \subset F\}$$

Where L is the set of all locations from where fingerprints were collected. A single location is represented by the relationship (Symbolic ID, Description).
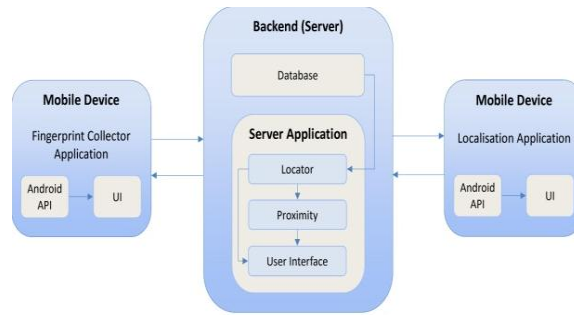
System Overview

Figure 22: An overview of the system. It shows the two mobile applications that connect to the server.

Figure 22 depicts this desirable architecture with the two mobile applications as the clients and the backend server which does all the necessary processing. The fingerprint collector application, as the name states, is the mobile application that will be used by the administrator of the system to collect fingerprints from different locations at that particular place. Fingerprints collected are sent to the server where they are processed and stored in a database as shown in Figure 22.

The other application will be used by users present in the building and measures fingerprints constantly without knowing the location. These measured fingerprints are sent to the server where they are compared to the fingerprints measured previously to obtain the location. The location resulted from the locator will be used to process the proximity with the other users currently connected to the system. All the results will be presented in a simple UI that displays all the devices connected and group information which can be used by rescue services to know where groups of people are and also contact them with information on what to do in case of emergency.

The modules in which this system consists from, map the architecture displayed in Figure 1. Below is a list, together with a brief explanation of the main modules of the system:

- The Fingerprint Collector Application Module – The module of the application that collects training examples
- The Localisation Application Module – The module of the application the collects measurements to recognise location.
- The Delegate Module – The module for all the interfaces required for the Façade design pattern of the data model.
- The Implementation Module – The implementations of the data model.
- The Database Module – The module that deals with the database.
- The Server Application Module – Module that deals with the processing done in the server like the locator and proximity parts.

IMPLEMENTATION

In this section, the implementation of the mobile applications modules and the algorithm implemented in the Server Application Module will be considered since these are the most important aspects of the system.

Mobile Applications Implementation

Most of the work in this system is started from the mobile applications, which are the two modules responsible from collecting data. Both applications gather Wi-Fi and GSM fingerprints from the environment, but with one difference between them. In the Fingerprint Collector Application the scanned fingerprints are assigned to a particular location, are sent to the server and stored in the database. On the other hand the Localisation Application continuously scans the area for fingerprints without assigning them to a location sends them to the server and the location is recognised by the system. To read fingerprints from the environment, it is required to get the data discovered by the device. Android [13], offers APIs to collect this data. These APIs are the Telephony Manager and the Wi-Fi Manager. With the data got from these APIs, fingerprints can be formed.

After all fingerprints are gathered they are processed to be sent to the server over an HTTP request. The method used to encode the data was to get similar information from all fingerprints and concatenate them together with a ';' as separator. These are then passed on the request as POST request parameters. Since there are GSM and Wi-Fi fingerprints, some information might not be relevant like for example when encoding the Cell ID of a GSM fingerprint the SSID should remain empty.

Algorithm Implementation

The algorithm implementation is split into 3 parts, the pre processing part, the localisation part and the proximity part. Pre processing is required because the fingerprints collected are not the same. With this processing the fingerprints collected from both applications will be normalised to be compared to each other. The main aim for pre processing is to have all measurements that have all the IDs from all the possible examples even if a particular ID is not found in that particular example. In this way all the measurements will be uniform in length and when comparing RSSI values each value is compared with the appropriate counterpart. To do this all the possible IDs must be extracted from the signal space.

Now that all the example measurements and the unseen measurements that will be received, will all have the same structure and can be compared to each other safely. Therefore, the Fingerprint Match Algorithm can now be implemented. Fingerprints from a training example and an unseen example will be compared to each other using the K-NN machine learning algorithm [12]. This is done for all the examples stored in the database. The comparison will be done using Euclidean Distance.

$$d(x_i, x_i') = \sqrt{\sum_n^{i=1} (x_n - x_n')^2}$$

Equation 1: Euclidean Distance [12] [4].

Equation 1 shows how the distance between two measurements is computed where x_i and x_i' are the RSSI values of the fingerprints in those measurements being compared. After computing the Euclidean distance from each training example to the unseen one a sorted list is produced of all the distances. With the list sorted, the k best results can be taken from this list [12]. To do this a loop is created that loops k times each time getting the next element in the list, until k is reached. Now from these k elements, how many times a particular location is found, is needed to be known so to assign the unseen example to a location. For this purpose a hash table object is created that will count how many times a location is found in the first k elements. There could be the possibility that two or more locations will be present in the first k elements of the results list the same number of times. To counter this, another hash table is implemented to maintain the shortest distance of a particular location to the unseen example. This way the location of the unseen example can be obtained.

Having found the location of a particular user using the Fingerprint Match Algorithm, proximity to other users can be found by comparing similar locations. To detect proximity the definition of a device and a group is needed because devices in similar locations are grouped together. This way all the devices and groups formed can be maintained in memory and easily accessed. With the list of devices at a moment in time the proximity between them can be found. This is done by looping through all the devices present in the system and comparing the locations of all the devices, grouping together those with the same location.

RESULTS

Results were obtained from two different parts of testing, the localisation testing and proximity testing. Localisation testing results showed that the system achieved a respectable level of success.
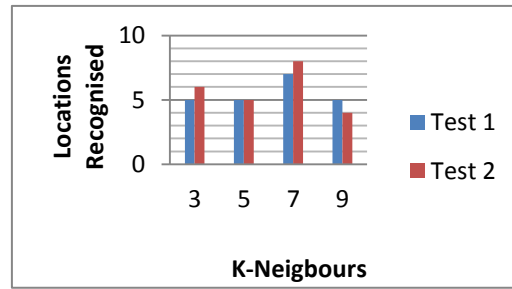
Figure 2: Recognised Locations results.

Figure 2 shows the results obtained when the localisation application was tested to see how many locations it recognised over *k* neighbours. From this graph it can be seen that over 7 neighbours the system produces the best results and reaches an accuracy of 7 out of 8 locations recognised or 83% accuracy. This compares well with the Redpin system [14].

That said still the system can oscillate between locations giving some wrong results. Even when the location was recognised, it could change to other locations since it is based on *k* nearest neighbours.
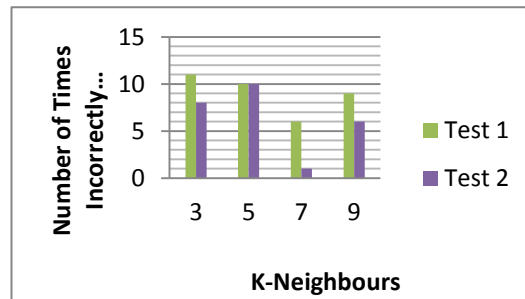
Figure 3: Number of times incorrectly recognising a location

Figure 3 shows how many times the system gave the wrong answer. As it can be seen the least amount of errors were given with 7 neighbours. This gives more credibility to the accuracy of the system.

Figure 4: Proximity results.

Figure 4 shows the results obtained from the proximity process after each device have been localised through the Fingerprint Match Algorithm. Note how depending on the location of each device the groups are formed. The locations of each device were once again estimated correctly.

CONCLUSION

The Fingerprint Match Algorithm was successfully implemented to obtain the current location of mobile users. Obtaining the location from it the system could then successfully estimate the group formations in the indoor

environments. These two objectives were successful due to the localisation application implemented to read fingerprints on the fly and also display the current location to the user.

Some problems could arise during localisation because of delays from the Android OS to make the required data available. This can lead to the system to recognise a location once the mobile device has moved to another location or the localisation application become stuck on the same location. Another setback is the nature of the K-NN algorithm; the localisation application can oscillate between different locations which will have a detrimental effect on locating correctly the mobile device. In the future other algorithms such as Support Vector Machines and Artificial Neural Networks could be used for the Fingerprint Match Algorithm to have more accurate results.

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Design and Implementation Issues of Mobile Learning: Lessons from Korean mobile learning project with 3G mobile phone

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ABSTRACT

The purpose of this study is to identify the practical issues on design and implementation of mobile learning by revisiting Korean mobile learning project. The Korean project was to develop a prototype of mobile learning for English class in middle school. The prototypes was developed based on 3G (3rd Generation) telecommunication technology and feature phone owing to mobile technology situation of Korea in 2008, 2009. There were some troubles to develop appropriate methods for mobile learning research such as evaluating the effectiveness of mobile learning prototype. We developed a research framework for revisiting the project process and outcomes by literature review as follows: model of mobile learning, development process of mobile learning, types of prototype output, methods for evaluating the mobile learning. Finally, we could get several issues for designing and implementing mobile learning as follows: i) how to redefine pattern of formal learning changed with mobile learning, ii) which levels of technology should we take for developing prototypes and how to spread outcomes, iii) which prototype should we take for design and implantation study, iv) how to exam the effectiveness of mobile learning or mobile learning prototypes, and v) who should participate in mobile learning project.

Author Keywords

Mobile learning, Koran Case study, mobile prototype

INTRODUCTION

The combination of wireless technology and mobile computing brought transformation of the world and education. Today we are witnessing a connected, mobile society with mobile technologies. Mobile technologies allow using IT without being tied to a single location and it also give personalized services. It gives new opportunities for learning. Learner can access customized learning environments anytime and anywhere regardless of their time and location with their own mobile device. They can search learning resources and interact with learning contents on mobile network when they want. That means learner control to manipulate the pages, order, content, and help offered during learning experience. These give learners a chance to play a leading role in learning process. We now have the opportunity to created extended learning communities, the link people in real and virtual worlds, to provide knowledge on demand, and to support a lifetime of learning(Sharlpes, 2007). Learning extends beyond the traditional teacher-led classroom and includes the daily life of the learners.

Mobile learning in Korea has grown for the last 10 years. It developed in two kinds of devices; Tablet PC (TPC) and mobile phone (Kwon et al, 2009). Mobile learning based on TPC is developed by digital Text book (DT) project which is

sponsored by government. Korean government attempted to develop hard ware and software platform of digital textbook for K-12. Disseminate of DT was not successful because cost for hardware and infra system. With this background, we need to find practical alternatives. One approach is to change device. We found 3G mobile phone—3rd generation (3G) mobile communication technologies and feature phone, which is a familiar part of the lives of most teachers and students in Korean today. Mobile phone allows user to make calls and send text messages. Mobile phone is not just a communications device. In 3G phone includes videophone function, internet accessing, data searching, Personal information management and virtual machine (VM) application. A Smartphone is a high-end mobile phone that offers more advanced computing ability and connectivity than a contemporary feature phone (i.e. a modern low-end phone). Nowadays, mobile phone can be regarded as a computer, but it still has some problems. It is more often regarded as bothersome distractions from the learning process. Most educators still see the computer and the cell phone as very interfering devices used among the young people. Mobile phone has small size, radio transmission, and communication as their core features and expanding out toward computing functions such as calculating. It means that we can use it as a mini-sized computer. Computer has expanded into communication and other areas either. So rather than complaining about the trend of kids coming to school with their own mobile phones, we should rethink them as a powerful learning device (Prensky, 2005).

The Korean project was a developing mobile learning prototype for English class in middle school. The prototypes was developed with 3G (3rd Generation) communication and feature phone owing to mobile technology situation of Korea in 2008, 2009. Researchers couldn't expect rapidly change of mobile technology in Korea. By introducing new mobile technologies such as full browsing technique, researchers had to imply it to prototypes. With this experience, researchers decided to develop prototype of mobile learning with most common technology even though technological development should be considered, to exam validities and to suggest research agenda of mobile learning. Finally, research teams could found a model of mobile learning for formal education and design principles of mobile learning. However, there were some problems on evaluating prototype and applying final product to the field.

We were trying to find out what we should learn from the Korean project. It brought out some questions to develop mobile learning system and prototype, to implement mobile learning, and to study mobile learning research. We decided to revisit this Koran project experience with several question. Why did the project output die out without much response? Which factors are determinant of success or failure in mobile learning project? What should be considered for designing and implementing mobile learning? What should we do effective mobile learning research?

The purpose of this study is to draw out design and implementation issues on mobile learning by reflection on Korean mobile learning project with 3G mobile phone. We developed research framework by literature review. The framework consisted of mobile learning definition, mobile learning development process, types of prototype output, and methods for evaluating the prototypes. With this framework, we analysed the Korean project and brought out some issues.

THEORETICAL BACKGROUND

Mobile learning

M-Learning means a learning environment in which instructors and students can access the learning system with portable devices and wireless network (Naismith et al., 2004; Gayeski, 2002; Kwon et al., 2009). With mobile technology, the educational environment is becoming better than before in ubiquity, instant connectivity, personalization, and self-directed learning-community (Jung, 2004). Gong (2004) analyzed m-Learning qualities with four characteristics: First, in m-Learning environment we can learn anywhere even if we are moving.   Second, we can access the learning system that we want, whenever we request and where we need.   This characteristic gives us a chance of self-regulated learning. Third, it gives a chance to enlarge learning resources. Each leaner can choose the material as his or her learning style and level, and it helps studying over individual differences.   Forth, m-Learning gives us the possibility of learning with real contexts. These let learners study and experience not separately, so that studying in m-Learning environments becomes actual learning.

Over The past 10 years mobile learning has grown from a minor research interest to a set of significant projects in schools, workspaces, museums, cities and rural areas around world(Sharples, Taylor & Vavoula, 2007). Mobile learning passed through three phases (Pachler, Bachmair & Cook, 2010). Korean mobile project could be classified by this three phases. In the first phase of mobile learning was a focus on device such as PDAs, tablets, laptops and mobile cell phone. This first phase made productive use of the affordances of mobile devices and technologies such as e-book, classroom response systems, handheld computers in classrooms, data logging devices and reusable learning objects. In the second phase of mobile learning was focus on learning outside the classroom such as field trips, museum visits, professional updating, bite sized learning and personal learning organizers. It was based on model of socio-cultural ecology (Yang, Kim & Kim, 2006). DT and mobile phone with Radio Frequency Identification (RFID) system was used to support it. This second phase made to support for the mobility of learning as it started to make use of location. In the third phases of mobile learning was a focus on mobility of the learner, the design or the appropriation of learning spaces and on informal learning and lifelong learning such as mixed reality learning, context sensitive learning and ambient learning. This third phase made productive use of interpenetration of the real world and the digital world. It enhanced our abilities to teach a vast range of subjects from biology to chemistry through to history and geography. With theses phases, we could conclude to consider hardware, software, systemware and infraware in order to design mobile learning.

Mobile learning based on mobile phone

As the purpose of this paper is concerned, we operationally defined mobile learning based on mobile phone mean that mobile learning system with 3G mobile phone supports printed Textbook in traditional classroom. Mobile phone is act as a mind tool ((Derry, 1990; Jonassen, 2006). Mind tools are aid that help to simulate high order thinking. It supports learners to express their idea, to represent their concepts, to exam their idea by visual representation. Learners are begins using mind tools properly. Learners who use mind tool can reduce their cognitive load (such as extraneous cognitive load; van Merriënboer, 2005) and they can focus productive thinking, and Learning. The teaching and learning theory of mobile learning based on mobile phone are self regulated learning, situated learning.

First, Context is a central construct of mobile learning. Context is continually created and changed by people in interaction and with other people, with their surroundings. Peoples also participate in their lives. Mobility in mobile learning can support learning in context. It means situated learning of Lave & Wenger (1991). Mobile learning can support meaning making from the flow of everyday activities. It is strikingly different with traditional classroom (Sharples, Arnedillo-Sanchez, Milrad & Vavoula, 2009). Traditional classroom learning is founded on a stable context, fixed location with a single teacher and agreed classroom. So, we included contextual learning to design principles of mobile learning experience. Learning experience of teaching and learning process should designed experience on Contexts of practice, participation in social practice, the learner, and the learning content. Learning in mobile learning is an integral part of generative social. Social world, person, learning content, and activity always integrated with the individual's identity and participation, the "production of persons-in-activity".

Second, learners needed to control their learning circumstance and their learning process in mobile learning. Learner could learn at everywhere and they could learn when they were moving. Learners could meet unforeseen occurrences that are out of their control. Locus of control of learner means that learners decided their learning goals, and planning, monitoring, and evaluating personal progress against a standard Learners could decide them according to their believes, desires, preferences. So, we included self regulated learning to design principles of mobile learning activities. Learning activities of teaching and learning process should designed contents structures as construct of self regulated learning such as plining, self checking, effort, and self-efficacy learning activities of traditional class consisted with three phases (See Figure 2). In before phase, there are four success factors for need to provide familiar factor, set learning goal, background knowledge, and submit assignment. In on-going phase, it needed to include four factors such as study contents, case study, quiz, and summarizing. In after phase, it joins up with elaborate and articulate activity, and facilitates using expression.

Third, learners should be struggled up to learning with discouragement such as data merging with scrolling the mini-size monitor, integration between printed textbook and mobile learning contents. It might cause cognitive overload. Germane load such as integration contents is a chance to raise high order thinking, but extraneous load such as operating the mobile phone interface is an obstacle to impediment learning(sweller, 2008). So, we included multimedia learning to design principles of mobile learning contents. Extraneous cognitive load should be minimized. We have to considered information processing model of multimedia (Mayer, 2008). Cognitive model of multimedia learning which consists of three memory store-sensory memory, working memory, and long term memory and five cognitive process-selecting words, selecting images, organizing words, organizing images and integrating. Multimedia of mobile learning process should design as cognitive theory of multimedia learning (Mayer, 2008).

Forth, learners feel inconvenience mobile phone interface. We can use mobile phone as a not only voice communication but also text communication. But, learners feel inconvenience keystroke interface such as 4×3 grid types keypad. We found that SMS language concerns more than acronyms and abbreviation. Sometimes senders wanted to remove space to reduce typing. So, we included multiple channel interfaces and include computer interface to design principles of mobile learning contents such as mobile pages and web report screen for teacher. We include "Hot key" to support flexible log in.

METHOD

Research framework

When designing learning activities and learning environment, it is important to consider learner's needs and learning objectives and what tools can support it. When we exploring mobile services for learners, it is important to understand the phenomena of mobile learning itself, as well as how to design and evaluate services and tools to support learning in varying mobile contexts to be able to develop better services and tools. O'Malley et al. (2003) developed guidelines for teaching and learning in mobile environments. Vavoula et al. (2004) more developed how to design and developed, which steps to take for preparing mobile learning. Theses group focused on designing model of mobile learning activities distinguishing from traditional classroom activities.

Some aspect to designing mobile learning is different from traditional learning system such as classroom learning or e-learning. Outside learning activities from classroom is included. It was not considered as main learning activities, it considered as additional activities. Everything was left to learners' own discretion. In mobile learning environment we can create pedagogical situation in each learners' lives. It is difficult to develop mobile learning activities and learning environment. To share images of mobile learning activities and artefacts between projects teams and stakeholders is not easy. To consider learners' context is not easy. There are many variations according the situation such as where they are in, what they want to do, who they work with. Prototyping approach is the alternative to this circumstance (Love, 2005).

An iterative approach was employed during the development of the prototype services. At each stage, target users and other HCI experts evaluated the prototype and provided feedback that was factored into subsequent redesigns. Howell, Love and Turner (2005) use spatial metaphors as a prototype of mobile city guide. They adopted a pilot test for examine ecological valid of mobile activities and environment. The design process consisted of four main stages leading to the design of the final prototypes that were used and evaluated in this study. The early stages involved mapping metaphors onto the service structure by using flow diagrams, modelling the dialogue and developing and testing successive prototypes under controlled laboratory conditions. The final stage involved testing the prototypes in realistic mobile contexts, which is the only way to provide for the wide range of competing activities and demands on users that might arise in a natural setting.

There are two types of prototype according to their fidelity. Low-fidelity prototypes are quick, cheap, and designed to elicit user feedback as early as possible. Low fidelity prototypes tend to be cheaper and faster to develop. Those are produced with materials that are further away from the final version. Paper and pencil prototype is best case of it. High

Fidelity prototypes can be thought of as prototyping through a medium such as video, where the prototype resembles the final system as close as possible. Commercial organizations often use high fidelity video prototypes because they make their product appear complete and aesthetically pleasing. High-fidelity prototypes are more expensive and usually involve coding, but are better for evaluating graphics and getting 'buy-in' that usability problems found during testing are not due to the 'rough' quality of the prototype. For instance, a version of a software interface with cut down functionality rather than a fully working high fidelity prototype. Iterative design can be achieved by the use of different kinds of prototypes in different stages of software design. Prototypes in the first phase of design are made to gather different forms of information as well as radically different alternatives. This prototyping phase will end at some undetermined point providing a proposal for an initial design. Low fidelity prototypes are suitable for this phase. Iterations are then made of the design based on test results received by running the system. By now any radical changes are unlikely due to production standards that now rule the system as well the expense factor of any major changes. This second phase can be regarded as a fine-tuning stage with a slow cycle time. We can use for design mobile learning system form the paper and pencil prototype , and passed the wizard of Oz (WoZ) or PNAMBIC (Pay No Attention to the Man BehInd the Curtain), and finally use real mobile programme for high fidelity prototypes. According moving to different types of prototype, we can add more test of effectives, userabilities, satisfactions of mobile learning activities and environment.

Methods for evaluating the prototype is depend on what the researchers want to know. Choice of the method also depends on who needs to know the results and how they will be used (Sharples, 2009). For testing mobile learning prototype, we can use experimental research and field study. Experimental research is used to test a user's learning process and results with developed prototypes. It is effective for verifying a hypothesis which is related with user's react to new intervention. However to design experiment is not easy because mobile learning give learners individual autonomy in their own from restriction of place and time. It is difficult to consider all variation of it, when designing research experimental. It is problem that experiment has to ignore unexpectable variables. Alternative approach is a heuristic evaluation with field study. It is a method for Usability test of core features of system of prototypes (Milich & Neilson, 1990). Researchers of field study evaluate systems with list of discovery design inventory. It is not for testing Usability test, but investigating the causes for the results. We developed research framework based on model of mobile learning, development process of mobile learning, types of prototype output, and methods for evaluating the prototypes.

category	description
model of mobile learning	・What will schools to learner bring in their own mobile multimedia communication tools? ・How can schools manage the tension between informal networked learning and formal instruction setting? ・What types of mobile learning are appropriated and cost-effective for schools?
development process of mobile learning	・Which steps were the project taken for designing, testing, implementing? ・What kinds of things to consider designing mobile learning activities? ・What kinds of things to consider to evaluated the mobile learning activities and environment? ・What kinds of thing to consider implementing the mobile learning project output?
types of prototype output	・Which kinds of prototypes were used for designing mobile learning? ・What kinds of process were taken for developing and validating the prototypes
methods for evaluating the mobile learning	・Which is the best way to test Usability? What is to be considered? ・Which is the best way to test effectiveness? What is to be considered? ・Which is the best way to test satisfaction? What is to be considered?

Table 1. Research framework of this study

Subject : Mobile learning project in Korea

The Korean case was supported by Korean government to improve English education and to develop another prototype different from Digital Textbook based on TPC. Digital Textbook had some problems such as difficulty to modify and improve, takes lots of time and cost to modify contents in time and fails to satisfy various learning needs of students (Kwon et al., 2009). It is difficult to revise the curriculum in line with the fast changing educational environment. The government failed to supply Digital Textbook Device, either. For that reason, some researchers interested mobile phone as another device of mobile learning. It is in general use between learners and teachers already. So the device of Korean mobile learning project is to develop m-learning prototype for English with 3G mobile phone.

For this purpose, there was a research project from 2008 to 2009.   Project teams reviewed some literature to exam the validity of mobile learning prototype with 3G mobile phone. They developed prototypes with the collaboration of two English education experts, four instructional designers, two mobile technology experts and Korean Educational & Research Information Service (KERIS), Korean Ministry of Education (MEST) and Busan Metropolitan City Office of Education (PEN). Actually, we were project members. We took parts in that project as instructional designers and experts of educational technology. Kwon was worked as a project manager. So, we recalled the experience of that projects, reviewed the meeting minutes and interim reports of the project and interviewed other project members.

RESULTS

Model of mobile learning

To Study foreign languages actively, learners need to actively be engaged in as follows: playing with words (verbal-linguistic), playing with questions (logical-mathematical), playing with pictures (visual-spatial), playing with music (music-rhythmic), playing with moving (body-kinaesthetic), playing with socializing (interpersonal), and playing alone (intrapersonal). It could be a help for audio-lingual approaches, communicative language leaning, grammar-translation methods, oral approaches and situational languages.   M-Learning for English is one kind of personalized and context sensitive foreign language training, supported by mobile devices (Markiewicz, 2006). It creates a lot of possibilities that are not achievable when using conventional langue teaching softwares on regular PCs, such as language learning through real-life situations and system access independent of time and locations. Naismith et al. (2004) discussed essential features for the foreign language education as contexts, mobility, learning over time, ownership. Consequently essential features of m-Learning for ESL are contexts, mobility, learning over time, ownership. It should include (i) audio-lingual approaches, (ii) communicative language leaning, (iii) grammar-translation methods and (iv) oral approaches and situational languages.

Therefore m-learning strategies for English are (i) mobility: access independent of locations, (ii) learning over time: access independent of time, (iii) contexts: learning through real-life situations, and (iv) ownership: self regulated learning. Mobile materials using in instruction support to teach and mediate learner's activities as a second textbook such as contextual assignment tool, learning material supporting artifacts, tool for solve the tasks and reflection guide.

We found a gap between drawing out a mobile solution such as supporting components for contextual assignments, leaning materials, solving the task and reflection.   It would offer a chance of problem solving by learners themselves. (See Figure 2).
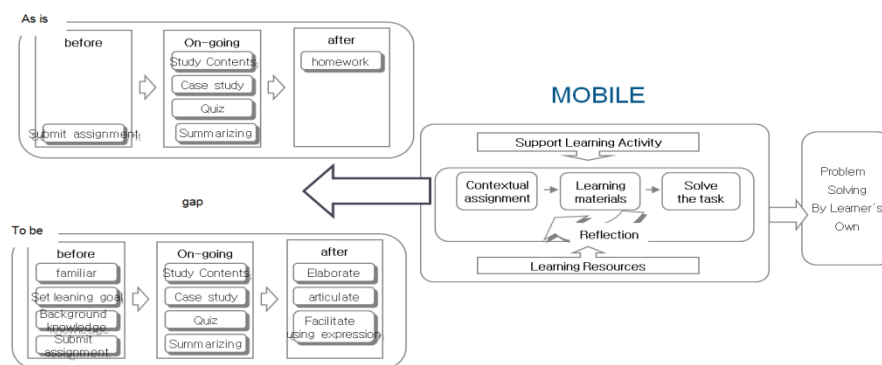
Figure 2. Need of Mobile English Learning Material

We applied design principles such as situated learning, self regulated learning, cognitive load theory and collaborative exercises of communication. That gave a shape to mobile learning activities and support systems. Mobile solutions such as contextual assignment strategy, learning material supports, opportunities to solve the tasks and reflection were supportable.

Development process of mobile learning activities and system

We developed mobile learning by iterative designing process between extraction of designing strategies, target setting and needs assessment and prototype development. First, we draw out a mobile solution for English education with need assessments. Those are the supporting components for contextual assignments, leaning materials, item pools and reflection. Further, we have taken an alpha type pilot test and elaborated on the m-Learning Prototype for English. The results show an increase in learners' accessibility of learning contents and their interest as well as teachers' ability of monitoring and providing feedback. Nevertheless, it has a little difficulty of imposing more time on learning time for both teachers and learners.
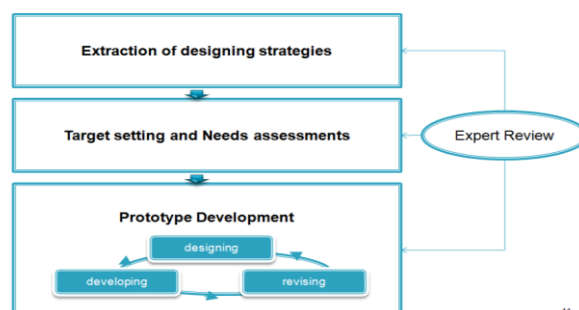
Figure 3. Development Procedure

Types of prototype output of mobile learning

We adopt both types of low and high fidelity prototype. We have developed paper and pencil prototype and elaborated it as an emulator prototype. Finally we developed high fidelity types with 3G mobile phone. Final prototype was consisted of mobile pages, websites for teachers, and a Web-based DB for learning management.

It consists of mobile pages (See Figure 4), a web DB and report screens for teachers (See Figure 5). Mobile pages contain the follows: reading practices, vocabulary training, self-checking, check-up tests, group activities, group activity boards in class, individual learning history (regarding incorrect answers), guides, information. The Web DB manages the leaning history of the learners. They could be categorized in lesson artifacts, collaboration artifacts, evaluation type and support artifacts. Some artifacts were added in revising procedure.

Figure 4. Snap Shots of mobile learning prototype for English

Figure 5. Snap Shots of Web DB and Report Screen

Methods for evaluating the prototype

We have conducted an alpha type pilot test with 30 H graduate school students who major in Educational technology and 5 mobile contents developers. This type of pilot test is for checking the sustainability of the prototype. The results showed that both content accessibility and learning interest of learners increased. In addition, it is useful for teachers to monitor different learning activities and learners' activity. On the other hand, it has a little difficulty of imposing more time on learning for both teachers and learners.

DISCUSSION: ISSUES OF DEVELOPMENTSTUDY ON A PROTOTYPE FOR MOBILE LEARNING

The Korean mobile learning project was very well regarded from a point of model and design principles of mobile learning (Kwon & Lee, 2010; Kwon, Lee & Keum, 2009). It was a basic research for choosing mobile phone as a device of mobile learning, developing mobile learning prototype based on mobile phone, and testing effectiveness and Usability of mobile learning. However, the process of the project was hampered by a variety of restrictions. Researchers struggled to overcome the restrictions such as raising fund for devices and networking, small sized screen of mobile phone, uncomfortable user interface. Results of Usability test and recognition of usefulness were not very effective. Outputs of the project such as final prototype were not spread out to the field.

We invested the reason why researchers experiencing such serious problems. We were trying to find out what we should learn from the Korean project. Why did the project output die out without much response? Which factors are determinant of success or failure in mobile learning project? What should be considered for designing and implementing mobile learning? What should we do effective mobile learning research? We suggested some issues of designing and implementing mobile learning.

Issues on properties of learning activities in mobile environment

Researcher of the Korean mobile learning projects had much difficulty in evaluating effectiveness of the model of mobile learning. It was because of several reasons. First reason was extension of the boundaries of space-time of learning in mobile learning environment. Mobile learning takes learners and other participants out into the conversations and interactions of everyday life. It is difficult to hang around learners' daily life. Researchers had some difficulties to developed scenarios of mobile learning and evaluate them. Second reason was extension of the range of device. Mobile learning should allow learners' liberty of choice device. Researchers had difficulties to count the number of case to use mobile device.

For such reasons researcher should develop a model of mobile learning to consider community system. It is difficult to consider social interaction of nation at the first time. It is better to start in small and to develop in big. Community

approach such as town   is stage of learning outside classroom (Cho, 2007). Mobile learning activities should consider this social interaction.

Issues on oversusceptible the rapidly changing technologies

The Korean project underwent a sudden change in mobile communication device from feature phone to smart phone. It is because of introducing 'iPhone' which is one kind of multimedia-enabled Smartphone of Apple Inc in 2009. Usage and behaviour mobile device and communication patterns based on mobile phone changed suddenly from one to one communication, such as text messaging and telephone call, to use of applications, such as interaction on social network service, information searching with location based service, meet a new experience with mobile augmented reality techniques. However, the project began in 2008. In that time, mobile device couldn't support to touch screen interface and wireless internet offered limited interactive data service with web browser for small mobile device called Wireless Application protocol (WAP). In the two or three years, way too much had changed. Actually, researchers less interested in the technological dimension but sometimes technologies led educational challenges or imposed restrictions.

For such reasons researcher should develop a sensitiveness to development of mobile technologies and make a decision to choice which is applicable technology. We suggested mobile research should consider technical realization but education experts should play an important role in shaping activities and intervention of mobile learning. To develop a useful model of mobile learning, it's prototype should be built in appropriate technologies not bolt on mobile technologies widely used now.

Issues on method of developing and validating prototypes

The Korean project developed paper and pencil prototype, emulator prototype and final product. With the experience, we learned invaluable lessons. First, mobile phone emulator enables to test the display of any website in many cell phones but it just gave a rough idea of the site would look. We used emulator to review mobile contents without having to purchase multiple devices or incurring data charges. It was useful to get an image of system architecture and visual design in early stage of developing mobile learning system. However, visual layout should be redesign after pilot test of final product. It was because of difference of interface between computer and mobile phone. Learner shift their posture when used computer and mobile phone.

For such reasons we suggest to use the wizard of Oz (WoZ) prototype for investigating using patterns and testing Usability. However, there could be some restriction on technical realization the results of Woz. It is not an serious problems. It is because mobile research wants to know how to design and implement activities of mobile learning and how to design artefacts to support activities of mobile learning.

Issues on development of appropriate methods for mobile learning research

Mobile learning research focused on both of classroom activities and outside activities form classroom. Researchers should have to concern with the social and cultural contests activities are located in, and characterised by the context and social and cultural practices created by them. Besides, it is needed to evaluate achievement, satisfaction and review the process to learn it for test effectiveness of mobile learning. Mobile learning included new learning activities that had not been considered as learning activities before such as observing in daily life and debating. Learners feel burden of learnig, take cognitive loads. Therefore, we have to carefully design the research for effectiveness of mobile learning

For such reasons we recommend to report process and the result. The process should include learning experiences, and cognitive loads, etc. The results should include achievement, effectiveness and efficiency.

Issues on team building of mobile learning research

It will be need co-working between education, computer science and participants of learning. Especially, it is needed in developing mobile learning scenarios. Mobile learning scenario should based on authentic model of mobile learning activities to reflect daily life of teachers and learners. It is difficult to apply daily life for experts but teachers and learners can help them.

For such reasons we recommend to participate teachers and learners in developing prototype. Teachers and learners could describe their teaching-learning work and daily life. Instructional designers elaborate them to scenarios. And then, computer science experts suggest technical challenges involved. In these processes, researchers should apply diverse fidelity types of prototype. With these prototypes, researchers should repeat to capture learning activities with mobile learning artifacts, to analyze using patterns and to ask for opinion of participants to modify the system. It will need a lot of time and money to perform iterative design process, so an association or government support will be formed to support mobile learning.

CONCLUSIONS

This research is to reflect a Korean mobile learning project and to draw out some issues on development and implementation of mobile learning. We suggested some issues such as over susceptible the rapidly changing technologies, method of developing and validating prototypes, development of appropriate methods for mobile learning research and team building of mobile learning research. It is our hope that this paper will yield general insights into mobile learning research and we will help to form an association or government support will be formed to support mobile learning.

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PART III: Doctoral Consortium

Research on System Architecture for Device Independent Applications for 3D Imaging and Virtual Reality

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ABSTRACT

Today's network landscape consists of quite different network technologies, wide range of end-devices with large scale of capabilities and power, and immense quantity of information and data represented in different formats. Research on 3D imaging, virtual reality and holographic techniques will result in new user interfaces (UI) for mobile devices and will increase their diversity and variety. A lot of efforts are being done in order to establish open, scalable and seamless integration of various technologies and content presentation for different devices including mobile considering individual situation of the end user. This is very difficult because various kinds of devices used by different users or in different times/parallel by the same user which are not predictable and have to be recognized by the system in order to identify device capabilities. Not only the devices but also Content and User Interfaces are big issues because they could include different kinds of data format like text, image, audio, video, 3D Virtual Reality data and other upcoming formats. A very suitable and useful example of the use of such a system is mobile learning because of the large amount of varying devices with significantly different features and functionalities. This is true not only to support different learners, e.g. all learners within one learning community, but also to support the same learner using different equipment parallel and/or at different times. Those applications may be significantly enhanced by including virtual reality content presentation. Whatever the purposes are, it is impossible to develop and adapt content for all kind of devices including mobiles individually due to different capabilities of the devices, cost issues and author's requirement. A solution should be found to enable the automation of the content adaptation process.

Author Keywords

Mobile Learning, content adaptation, device independent learning, device detection, generalized content

INTRODUCTION

Mobile learning, through the use of mobile technology, will allow citizens of the world to access learning materials and information from anywhere and at anytime. This idea will literally come true only after a worldwide successful implementation of presentation of device independent learning content. The identified barriers that have to be taken care of to support device independent mobile learning are: 1) Various kinds of devices used by different users or in different

times/parallel by the same user which is not predictable and have to be recognized by the system in order to know device capabilities (Gaedke, et al, 1998) In a stable place like at home or at office it is more convenient to use a PC. While on the move it is very obvious that a user would like to access same content with the same outlook and feel by using his mobile device. So a system is necessary which is device dependent from the point of communication functionality, interactivity, 3D capabilities, and information presentation and information depth. But at the same time it must be device independent from the point of information access, and (a-) synchronous communication possibilities (Caballe, et al, 2010). 2) The overall number of users of specialized content or interactive applications is too low to adapt the application/content to all possible devices manually. 3) Content and User Interfaces could include different kinds of data format like text, image, audio, video, 3D Virtual Reality data and upcoming other formats (Meawad, et al 2008). The system should be able to deal with all the existing and upcoming formats of data without requiring any huge enhancement. The goal of this research work is to find a way to solve the above stated problems by investigating system architectures to provide unconstrained, continuous and personalized access to the content and interactive applications everywhere and at anytime with different devices. Especially for future UIs using media photonics like holographic interfaces this is an outstanding issue for further research. A very suitable and useful example of the use of such a system is mobile learning because of the large amount of varying devices with significantly different features and functionalities. In order to realize such a system three major requirements have to be fulfilled a) Identification of the connected device b) Generation, structuring and storage of generalized content c) Transformation process from generalized content to optimized and device dependent content

IDENTIFICATION OF THE CONNECTED DEVICE

WURFL is selected for the description of the features of mobile devices and browsers because WURFL model is an XML configuration file which contains information about capabilities and features of many mobile devices in the wireless world. Also, the repository of device in WURFL is updated every day by contributors in the world. So it is an up to date specification that brings reliability in device data manipulation. Our system works with a combination of WURFL and a local database. Figure 1 below shows the whole process.

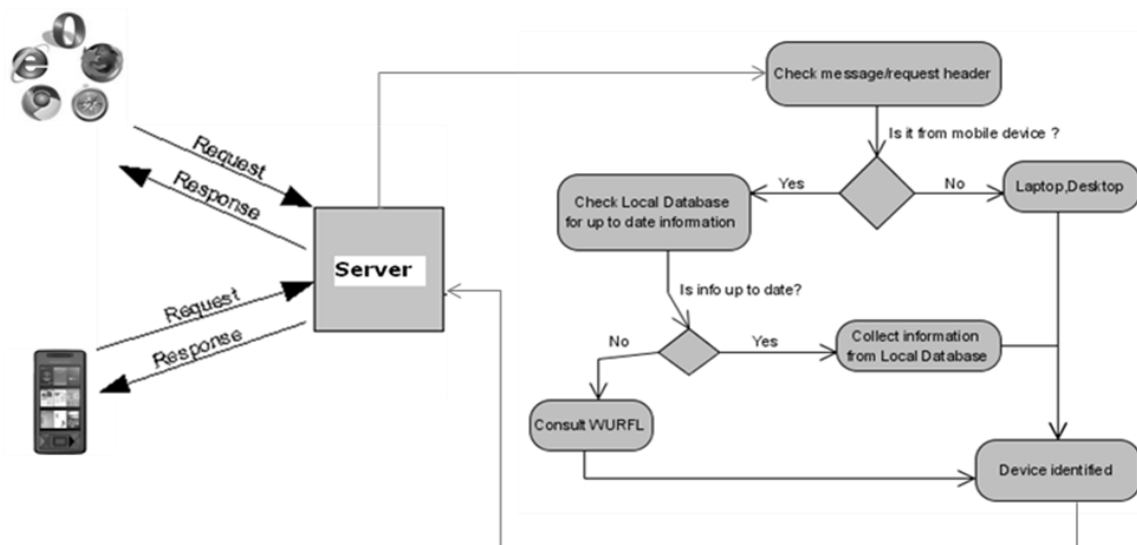**Figure 1. Process of device detection (based on Caballe et al, 2010).**

First, it is detected whether the user is connecting to the system via mobile device or by desktop device by analyzing the user-agent parameter of the HTTP-header. Accept parameter of the HTTP-header shows what can be supported or rendered by this client. Table 1 shows example of message headers from different devices and the response of the server:

Request from Laptop Browser	Response from the server
GET / HTTP/1.1	HTTP/1.1 200 OK
Host: www.google.de	Date: Mon, 29 Aug 2011 07:41:16 GMT
User-Agent: Mozilla/5.0 (X11; U; Linux i686; en-US; rv:1.7.12)	Expires: -1
Gecko/20050920	Cache-Control: private, max-age=0
Accept:text/xml,application/xml,application/xhtml+xml,text/	Content-Type: text/html; charset=UTF-8
html;q=0.9,text/plain;q=0.8,image/png,*/*;q=0.5	Set-Cookie:
Accept-Language: en-us,en;q=0.5	PREF=ID=1a8c277baf1f8905:FF=0:TM=1314603676:
Accept-Encoding: gzip,deflate	LM=1314603676:S=ZlEHjAj6ssqLt1vx; expires=Wed,
Accept-Charset: utf-8,*	28-Aug-2013
Keep-Alive: 300	07:41:16 GMT; path=/; domain=.google.de
Connection: keep-alive	Set-Cookie:
	NID=50=ewkG8txoy4-nLjYZFnGtsUne8VcVYZh6V3WK
	8JAdWyMV7qRtCGYgbRYzPYFkFKKGJSdW8BspyMWoDw
	8ewU2
	uUN2D39myvEQYKQB9PbDRt3cpj2jfD3o_mYryyOxorE9Q;
	expires=Tue, 28-Feb-2012 07:41:16 GMT; path=/;
	domain=.google.de; HttpOnly
	Content-Encoding: gzip, Server: gws, Content-Length: 10285
Request from a mobile device (iPhone)	**Response from the server**
GET / HTTP/1.1	HTTP/1.0 301 Moved Permanently
Host: www.spigel.de	Date: Mon, 29 Aug 2011 07:39:44 GMT
Accept:text/css,*/*;q=0.1,application/xml,application/xhtml+x	Server: Apache
ml,	Location: http://www.spiegel.de/
text/html;q=0.9,text/plain;q=0.8,image/png	Content-Length: 230
Accept-Encoding: gzip, deflate	Content-Type: text/html; charset=iso-8859-1
Accept-Language: en-us	X-Cache: MISS from lnxp-3954.srv.mediaways.net
Connection: keep-alive	X-Cache-Lookup: MISS from lnxp-3954.srv.mediaways.net:101
User-Agent: Mozilla/5.0 (iPhone; U; CPU iPhone OS 3_1 like	Via: 1.0 lnxp-3954.srv.mediaways.net (squid/3.1.4)
Mac OS X; en-us) AppleWebKit/528.18 (KHTML, like Gecko)	Connection: close
Version/4.0 Mobile/7C144 Safari/528.16	

Table 1. Message headers from different devices

In case of mobile devices, the local database is checked whether the device is listed and the available information is up-to-date. Outdated device information is determined by using the WURFL.

GENERALISED CONTENT

A device independent system is able to deliver content to any device in such a way that the received content can be presented. This task can be approached in two following ways: either content for every device exists in the system, which is very time, cost consuming and labor intensive, or the system is able to adapt content for each device. In case the system is capable of adapting content to a device dependent presentation, the content has to be available in the system in a generalized form. Additionally, such a system should support a device independent authoring process where the author can focus on the content generation and not on device dependent content adaptation. XML has been chosen for generation, structuring and storage of generalized content. The reasons behind this decision are, XML has been considered and proven to be adequate and a powerful technology to store content in a presentation independent manner. By defining an additional attribute inside the XML tags, it is possible to classify the content. At the same time, this will help the

author to generate learning material for different devices in an efficient and structured way. Moreover, the content can be used in different formats (XHTML, PDF, etc.) as well as with different technologies (browser, applet, MIDlet, Ajax, etc.). XML can be and is used with quite different concepts for interactive distributed applications for both PC-based and mobile networks using internet technologies. It offers the perfect solution for handling data for device dependent presentation because it structures the data without specifying the visual presentation contrast to HTML (HyperText Markup Language) (HTML 4.01 Specification, 1999). Thus it allows reusing data to generate different device specific presentations with the help of templates. Another reason behind using XML based data storage for our system is it allows the author to classify their content according to the importance of the content and not according to different devices. Usually authors tend to generate their learning material for PC and laptop usage and later on strip it down to adjust the content to lower end devices like mobile phone. As a result, content may become incomprehensible and nearly unreadable. Furthermore, cutting down content may result in loss of important relationships. In our system, content, which is less important, can be omitted on lower end devices without losing the relations of the learning content because the author has to start with the essential learning content (Table 2). This information has to be presented on all devices. The additional information has to be tagged as for example level: important, relevant or optional. Indeed, the system evaluates which content class fits best to a device group, though the system does not automatically decide on the importance of the content. Specifying the level attribute remains the important responsibility of the author of the learning content and it has to remain like this.

LEVEL	CONTENT
Essential	This is essential part of the content
Important	This is essential part of the content. This is important part of the content
Relevant	This is essential part of the content. This is important part of the content This is relevant to the content
Optional	This is essential part of the content. This is important part of the content This is relevant to the content This is optional part of the content

Table 2. Different level of learning content

CONTENT ADAPTATION

In order to optimize the content presentation on different devices, the generalized content has to be adapted or translated in to a device dependent manner. W3C in W3C-MBP (2008) has categorized three approaches where the adaptation is taking place: 1) client-side, 2) server-side and 3) proxy-side. Our system is using both the server and proxy side approaches based on necessity. For 3D data or virtual reality scene, it is advantageous to use proxy based approach (Feisst, 2006 PhD thesis). When a mobile device requests a specific 3D Virtual Reality file, the device has to inform the proxy about the device capabilities, such as processing power, screen resolution, supported sound formats and so on. On the proxy side, the specific file is requested from a target server. By parsing this file, the proxy creates an object oriented representation of that scene. Additional resources (e.g. links to other files) can be detected and preloaded. The proxy will remove unneeded and unsupported content according to the mobile device specification. In 3D Virtual Reality scene additional content such as sound and images can be included. If the mobile device does not have the required capabilities to provide this information (e.g. play back sounds) it does not make sense to transmit the data over the wireless network. This information can be removed at the proxy without any loss at the client side. The 3D Virtual Reality scene is

transformed into the correct modeling language while mentioned methods are taken into account to reduce the content. The idea of the process could be picturized as figure 2.
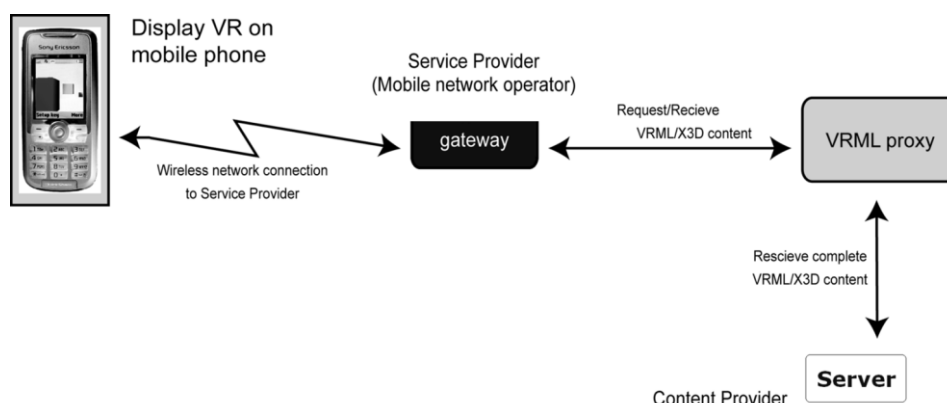

Figure 2. Process of displaying VR data on mobile device (based on Feisst, 2006 PhD thesis).

Besides, Wireless Abstraction Library from WURFL (WALL) is used to realize content adaptation according to the mobile device. It gives the author the possibility to mark-up his content with WALL tags that are automatically transformed to the correct tags supported by the connected device afterward. For example the tag *<wall :br>* is transformed into *
* for devices which uses CHTML and to *
* for WML or XHTML MP enabled devices. In addition to it, WALL has the ability to assign specific content on the basis of the individual device capability provided by the WURFL database. The following fragment of a WALL document shows the principle on the example of the supported image format. In case the connected mobile device supports GIF images, the "test_image.gif" is used, otherwise the WBMP image "test_image.wbmp" is used.

<**c**:choose>
<**c**:when **test="${test.gif}"**>

</**c**:when>
<**c**:otherwise>

</**c**:otherwise>
</**c**:choose>

CONCLUSION

The aim of this research is to establish anytime anywhere learning independent of place, time, device, data format of the learning content and end user ś status. To achieve this goal first step is to identify connected device to know its capabilities, second step is to prepare generalized content from the learning material provided by the author, then third step is to translate and transfer generalized content according to the capability of end user ś device. To make the process more realistic it is also a necessity to support different devices owned by same user used parallel or at different times. Primarily the idea is tested with text and .jpg data format in platform type Connected Limited Device Configuration (CLDC)/Mobile Information Device Profile (MIDP). CLDC – 1.1 and MIDP – 2.0 was used with some optional packages like Mobile 3D Graphics 1,1, Wireless Messaging 2,0 etc. So far device detection, generation, structure and storage of generalised content and translate and transfer of the generalised content according to detected device ś capabilities with above mentioned data and device profile is working. Still it has to be tested with other possible devices and data formats, specially with 3D data and VR scene.

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Toponimo: A geosocial Pervasive Game for English Second Language Learning

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ABSTRACT

This paper provides an overview of progress on the Toponimo project, a geosocial game for learning simple, location significant vocabulary. At the core, the technology relies on a crowd-sourced database of individual words which are 'linked' to physical locations via GPS data. A simple scoring system awards players for collecting and adding words to their environment. When adding words to the shared database, the player also has the option of adding other media such as images and sound files which will be associated with that location. This core mechanic can be expanded upon by a plug-in architecture which allows mini-games to be built 'on top' of the core game engine. We expect that these games will present rich opportunities for learners to acquire and rehearse vocabulary.

Author Keywords

Language learning, mobile learning, client server, context, vocabulary, motivation, user created content, informal learning, social, location-based, game, geotagging

INTRODUCTION

When designing mobile learning technology, a central concern must be not only how the user interacts with technology but how technology can interact with the physical environment to create new contexts for learning (Sharples, Taylor, & Vavoula, 2005). This also has a bearing on how technology can act as a mediator for human-human interactions. This paper provides an overview of the Toponimo project, a current work in progress which combines contextual learning with social networking, crowd-sourced content and location-based pervasive gaming. The aim of Toponimo is to support learning of second language vocabulary by linking words or phrases to locations chosen by the learner and shared with other learners in a social game.

BACKGROUND

A prime factor of successful language learning is the frequency and quality of input (Carroll, 1999). Ellis (1991) reports that the frequency of exposure has considerable effect on various aspects of language acquisition including phonology, morphology, vocabulary and syntax, going on to suggest that learners who receive a greater frequency of input generally attain a higher level of proficiency in the target language. Additionally, it has been demonstrated that collaboration amongst peers can provide a rich means for language input, rehearsal and sustaining motivation (Dörnyei & Malderez, 1997).

While there has been a number of studies conducted on Mobile Mixed Reality games, e.g. Uncle Roy all Around You (Benford et al, 2004), Can You See Me Now (Benford et al, 2006), Day of the Figurines (Lintham et al, 2007); as of yet, much of this work has occupied a collaborative design space between Computer Science and Fine Art with the intention of creating playful experiences. While there has been some previous work which uses location-based technology for

vocabulary learning (Anderson, Hwang, & Hsieh, 2008; Chen & Tsai, 2009; Ogata, Hui, & Yin, 2008), to our knowledge there has been little work which has investigated how location-based learning and crowd-sourced content can be combined with pervasive gaming for second language learning.

Montola (2005) helped define three central characteristics unique to pervasive games. They suggest that pervasive games offer:

- **Spatial Expansion:** The player inhabits a play space which stretches beyond the virtual to the physical. Location-aware technologies allow players to inhabit and play within real spaces as they would with virtual spaces.

- **Social Expansion:** Collaboration and communication is promoted via telephonic and digital network-based technologies. Social relationships are strengthened via player and player interactions.

- **Temporal Expansion:** Games can be played over lengthened time frames, weaving within daily activities. Games can be played when and where the player chooses, fitting in with space and time constraints. The game can become part of the player's daily routine, seeping in to the background when needed and allowing the player to be an active participant in the game world even when not actively engaged with the game.

With this framework in mind, we can see how such games may provide a rich and novel method for language learning. The temporal aspect of engagement can provide the learner with a means to 'dip in' to the game when needed or at previously unused time slots. This non-intrusive method can supply a relaxed, non-threatening atmosphere for the learner. The spatial play space offers a visually rich playground for the learner to explore, acquire and practice contextually relevant language. The social aspect of pervasive gaming provides the learner with means of interaction, language input and rehearsal.

GAME OVERVIEW

There are two aspects to the game, the Core Engine and the Gamelet Layer.

Core Engine

The core engine incorporates a simple geosocial game mechanic which rewards players for 'collecting' and 'placing' words in their current environment. The key here is to encourage users to interact with their physical and social environment by rewarding them with vocabulary points. We expect that natural, friendly competition will arise when players attempt to beat each other's score. Each player starts off with no points. Points are awarded in one of two ways:

Collecting

When the user collects words from the database they are added to their word store. The player is awarded a single point for each word collected. Users are allowed to collect the same word more than once although not from the same location.

Placing

Players add words to their current location. Each word carries a five point reward. If the word has already been added to the current location (by another player) then only two points are awarded. A player may only add one occurrence of a word to a single location. Users also have the option of placing images of their location to accompany the words they have added. The picture can either be a representation of an object or convey a more narrative aspect of the current context.

Gamelets

"Gamelets" are mini-games which use the core engine as a base for more complex game mechanics. We are currently developing two gamelets as part of the prototype system. The first is a text adventure game which uses the player's physical environment as a basis for the game's underlying narrative. The second is a treasure hunt game where players seek out hidden items in their environment. We envision that both games will have both collaborative and competitive aspects. While these games are simple, they do show how the simple core mechanic of collecting and placing words can be built upon to create more elaborate games.

DESIGN AND IMPLIMENTATION

We are developing Toponimo using an iterative design methodology. Wireframe prototypes (Figure 1.) were created using Adobe Photoshop and Powerpoint and were evaluated by a team of staff and students at The Learning Sciences Research Institute and a small research team at Sharp Labs Europe. The feedback from the prototyping sessions has proven valuable in informing further revisions to the design.
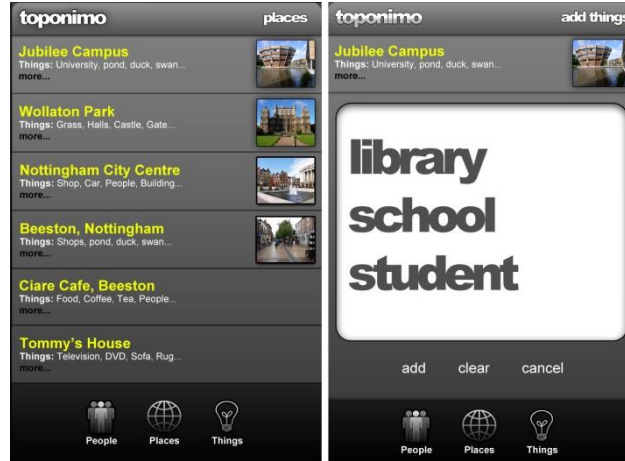

Figure 1: Mockup of the 'places' and 'add things' screens.

Even at this early stage several problems and questions were raised such as how the crowd-sourced material will be evaluated for authenticity, i.e. how can we ensure that the language presented to the player is relevant to their location? Another, associated concern is how to accommodate change in the environment such as people and objects being tagged and photographed but not being present in the environment on subsequent visits? In response to these concerns we have implemented a simple five point ranking system which will allow users to 'rate' words based on their perceived relevancy to the environment. A simple Bayesian average algorithm ensures that even with a limited amount of ratings, words remain within the average rating of all items.

$$\overline{w} = \frac{\overline{N} \cdot \overline{R} + n \cdot r}{\overline{N} + \overline{R}}$$

Where $\overline{N}$ is the average number of votes for all words, $\overline{R}$ is the average rating for all words, n is the number of votes for the current word and r is the rating of the current word.

Technical Development

Toponimo is a client/server application. The server side runs on a traditional LAMP software stack. Communication between the MySQL database and the client side is handled by custom software written in PHP. The client runs on Android 2.2 devices and connects to the centralized server either via a Wi-Fi or a 3GS connection. We have finished completion of the first working prototype which is currently undergoing usability testing.

EVALUATION

The first working prototype is nearing completion. Trials will be conducted using ESOL students attending a local Further Education College here in Nottingham using a quasi-experimental nonequivalent groups design. All students will undergo a baseline pre-test phase as a measure of their basic vocabulary skills. All words used in the pre-test phase will be words encountered later during the evaluation of the mobile application. Two versions of the software will be used in this study. The first version will place the user in a purely receptive role, delivering contextual language to the user based on their location. The second version will allow the user to interact with the application by adding words and phrases to the application based on location. Participants will be split into two groups with a version of the software allocated to each

group for a period of two weeks. After this period the participants will undergo a vocabulary level test using the same materials as the pre-test. As a secondary consideration, attitudinal data will be collected via questionnaires and focus group discussion. This will help ascertain the desirability of the system and potentially highlight any weaknesses in the interface and aesthetics of the application. From here we expect to gain valuable data which can be used to further the design and development of the game.

CONCLUSIONS

While we are currently at the early stages of software development for the Toponimo client we would hope that the informal style of interaction afforded by the application will allow players to interweave their language learning with everyday life, providing exposure to language which is contextually relevant to the learner. Additionally, we envision that the game aspect of the application will help sustain learner motivation over time, allowing players to 'dip-in' to the games when needed.

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Development of a local economy and money transfer on mobile phones in rural Africa: the case of bikoula

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ABSTRACT

Bikoula, a village in Cameroon, has been equipped with smart phones. As most of the villagers are illiterate, oral exchanges through menus are the only way to proceed for a request for information. Vocal services in local language should be provided in return to guide the user. Online informal tutoring activities are organized through a community radio station with interactive broadcast sessions. The objectives are to train the villagers how to use their smart phones for mobile banking, micro banking as well as bartering with virtual currencies.

Scenarios: 1-peasants connected to a local language based online content, 2-Learning mobile banking, micro banking, using virtual currencies.

(Full paper included in the disc.)
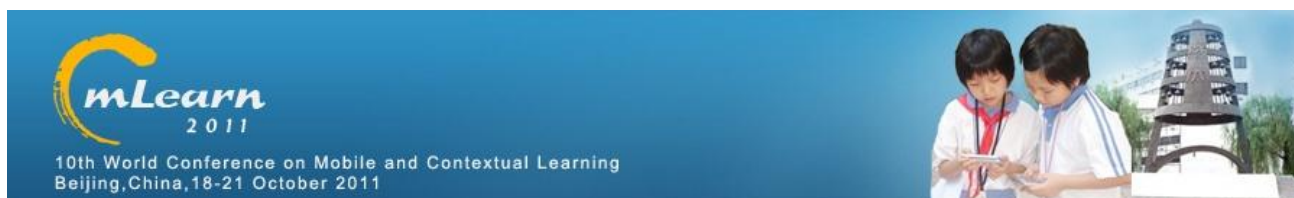
mLearning Curriculum Design for Undergraduate English Language Learning

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ABSTRACT

Mobile learning (mLearning) as a research field in its own right has been active for at least the last 10 years due to its wide availability and learners' preferences of mobile technology. The conventional formal classroom learning has been further challenged with the rapid transformation of online society (characterized by PCs, desktops, landline internet, and notebooks) to mobile society as the individuals are another stage higher liberated from information and knowledge hardship. Thus, academicians and researchers have debated on how mLearning could and should be incorporated in mainstream (conventional) education. Among the major issues would be on how mLearning should be designed to deliver education. This paper describes a doctoral proposal on the design of an mlearning curriculum focusing on English Language Learning at the undergraduate level.

Author Keywords

mLearning, language learning theory, scaffolding, interaction

INTRODUCTION

When we address 'Mobile learning or m-learning', augmentation should be the fundamental way in looking at it (Metcalf, 2006). Quin (2011) elaborated from this point that mlearning is not about learning or a solution to formal learning; it is about providing support to learning and also about learners' performance. (p.19). Although m-learning at its infancy stage, its foundation can be tracked back more than thirty years ago with the Xerox Dynabook project which introduced a portable self-contained knowledge manipulator that impressively allow children to explore, create and share dynamic games and simulations (Kay, 1972). This project gave birth to personal computing development and triggered studies in technology enhanced education. However m-learning only begin to develop significant potential impact on future education about a decade ago through significant projects in schools, workplace, museums, cities and rural areas worldwide. The projects scale from revision exercises for children through mobile phones (BBC Bitesize Mobile[19]), small group classroom learning via handheld computers (Zurita & Nussbaum, 2004), improving learning opportunities and self-development of school drop-outs(Mlearning Project Pembrokeshire College[20]) to context-based learning in museums and workplaces (Brugnoli et al., 2007). Though m-learning has high potential for future curriculum, a worldwide implementation of most technological based learning like its predecessor, e-learning, would fall short due to several pedagogical issues. One of the major issues would be the curriculum design. Despite the vast studies in m-learning, there is still a large gap in the studies especially in

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[19] http://www.bbc.co.uk/schools/gcsebitesize/mobile/

[20] http://mlearn.pembrokeshire.ac.uk/files/final_report.pdf

the design of an m-learning curriculum for a specific subject area for a specific education level. Hence the study focuses on the development of m-learning curriculum for undergraduate level English Language learning.

OBJECTIVE OF STUDY

The main objective of this study is to design an m-learning curriculum for undergraduate English Language course. The study consist of three phases, the objectives of each phase are as described:

- To identify the needs of m-learning in undergraduate level based on lecturers' views.

- To develop an m-learning curriculum for undergraduate English Language learning.

- To evaluate the curriculum design of m-learning for undergraduate English Language learning among students.

METHODOLOGY OF STUDY

The study adopted two models as a theoretical framework for curriculum design and development. The first model is TABA Curriculum Development Model (1962) which is used to develop the m-learning curriculum and the second model, Instructional System Design Model (Tsai, Young, & Liang, 2005) is used as a base for specific design of moblogging based m-learning curriculum. Consequently, the study applies the Developmental Research Approach which consists of three phases to develop an m-learning curriculum for undergraduate English Language course.

Prior to the first phase, would be a systematic review of literature in constructing a set of structured survey questionnaires to seek the needs of m-learning curriculum design for undergraduate language learning. To ensure validity and reliability of the questionnaires, the researcher will present the questionnaires to three (3) curriculum experts to determine its construct validity. A pilot study using the survey questionnaires will also be carried out on lecturers. Responses from the curriculum experts and results from the pilot study will be used to improve the questionnaires prior to needs analysis. The first phase of this study involves a needs analysis for m-learning curriculum based on lecturers' views. The analysis will be conducted via survey technique to identify needs for m-learning implementation based on the instructors' views. The instructors will consist of lecturers who have Information and Communication Technology (ICT) skills and knowledge who are better informed in current educational technology as they are teaching ICT related subjects. The researcher also plans to include a group of language lecturers from the same institute to inform on the needs of language teaching and learning for the intended curriculum design. The outcome of the survey will be used as a basis for m-learning curriculum design for the undergraduate language course. The second phase is the curriculum design phase, conducted via a modified Delphi technique. Delphi technique is used to attain experts' consensus on elements which should be included in the curriculum design. Delbecq, Van de Ven, and Gustafson (1975) cited in Wiersma & Jurs (2005) defined Delphi technique as a method for the systematic solicitation and collection of judgments on a particular topic through a set of carefully designed sequential questionnaires interspersed with summarized information and feedback of opinions derived from earlier response (p.10). This technique was designed to elicit group opinions of experts in decision making of the future, and as such has been enthusiastically adopted by researchers and education planners in education settings such as planning university campus and curriculum development (Linstone & Turoff, 1975). As the study seeks experts' consensus on the most desirable elements which should be included in the curriculum design, the researcher adopts a normative Delphi (also called a consensus Delphi), which is useful in focusing on establishing what is desirable in the form of goals and priorities (Yousuf, 2007). Moreover most Delphi studies in educational settings are normative as supported by Rieger (1986) cited in Yousuf (2007) who stated, "... it seems reasonable to claim that Delphi is continuing to be a much used tool in the search for answers to normative questions, especially in education areas, but also in other fields". Hence the study proposes to use normative Delphi technique which will be conducted in three rounds. The first round involves responses from selected experts to questionnaires which contain a list of curriculum needs derived from the lecturers' responses (from phase one). The selected experts will be a mixed group of experienced educators especially from ICT and language backgrounds, major stakeholders, policy makers, researchers on similar field, and curriculum experts from

both local and international countries. Coupled with the list would be open ended questions to allow the experts to add their opinions. This phase is a modified Delphi as the panel experts are provided with the list rather than having to generate such a list. The main purpose here would be to provide information to further refine the list. The second round focuses on attaining consensus from the experts. The panel experts will be given the refined list of items generated in round one and they will be asked to rate all the round one items based on Lickert scale to items formed in phase one (needs analysis). Responses will be analyzed for their median and inter-quartile range. In the final round (third), each experts will receive the summarized and synthesized response from round two and they will be able to observe the rated items. Each panel member should be able to understand their position for each item compared to that of the panel as a whole. This is the final round; therefore the content of the questionnaires should set the stage for final ratings and rankings. Experts will decide and place their final responses for each of the items. Any panel member whose final responses remain outside the range of consensus should justify his or her position in this round.The result from this phase will be used to design the curriculum. The third phase is the evaluation of the curriculum. Evaluation of m-learning curriculum will be conducted through a language subject (rated highest by experts) offered to the students in their institution. In this phase, 12 teaching and learning session (aligned with the 14 weeks system in a semester) of the subject will be conducted using the undergraduate m-learning curriculum design produced from phase two. The curriculum will be   evaluated using State Countenance Model of Evaluation (SCEEM). This model is chosen its suitability in assessing a program holistically at all three levels: antecedent, transaction and output (Milner, 2000). All data for phase one to three will be analyzed using the latest version of statistical package for social science (SPSS). The study proposes the analysis of mode and mean scores in phase two to determine the needs of m-learning at the undergraduate level based on lecturers' views. The result of the analysis will be used to prepare a survey questionnaire for round one of Delphi technique in phase two. The major statistics used in Delphi studies are measures of central tendency (means, median, and mode) and level of dispersion (standard deviation and inter-quartile range) in order to present information concerning the collective judgments of respondents (Hasson, Keeney, & McKenna, 2000). However it is proposed that data gathered in phase two of this study will be analyzed using median and inter quartile range based on Likert-type scale. The use of median is aligned with the literature which favors the use of median score (Jacobs, 1996) cited in Hsu & Sanford(2007) as Jacobs argued "considering the anticipated consensus of opinion and the skewed expectation of responses as they were compiled, the median would inherently appear best suited to reflect the resultant convergence of opinion" (p. 57). In another point of view, Boonan (1979) supported inter-quartile range as having higher precision compared to mean score in describing differences in experts' views on each items. In phase three of this study, through SCEEM, the curriculum will be evaluated by analyzing the derived data using congruence analysis. In short, the study is conducted in three (3) phases. The following Figure 1 is the flow chart of the methodology described here.

TARGETED RESEARCH FINDINGS

By the end of the study, a mobile learning curriculum for Undergraduate English Language Learning will be produced based on the analysis of the experts' opinion. In detail, the findings of the study is projected to reveal essential elements which needed to be included in the design of the m-learning curriculum for English Language Learning for undergraduate level. Among the elements would reveal on the objectives of the intended curriculum, types of hardwares/softwares, electronic services, support infrastructures in the campus, implementation method, curriculum content, teaching and learning strategies, lecturers' skills, students' skills, and form of assessment. Besides this, an m-learning curriculum module for a selected undergraduate English Language course will be designed based on the elements illustrated by the findings. Based on the evaluation of the curriculum module, it is projected to be suitable and effective in mobile language learning.
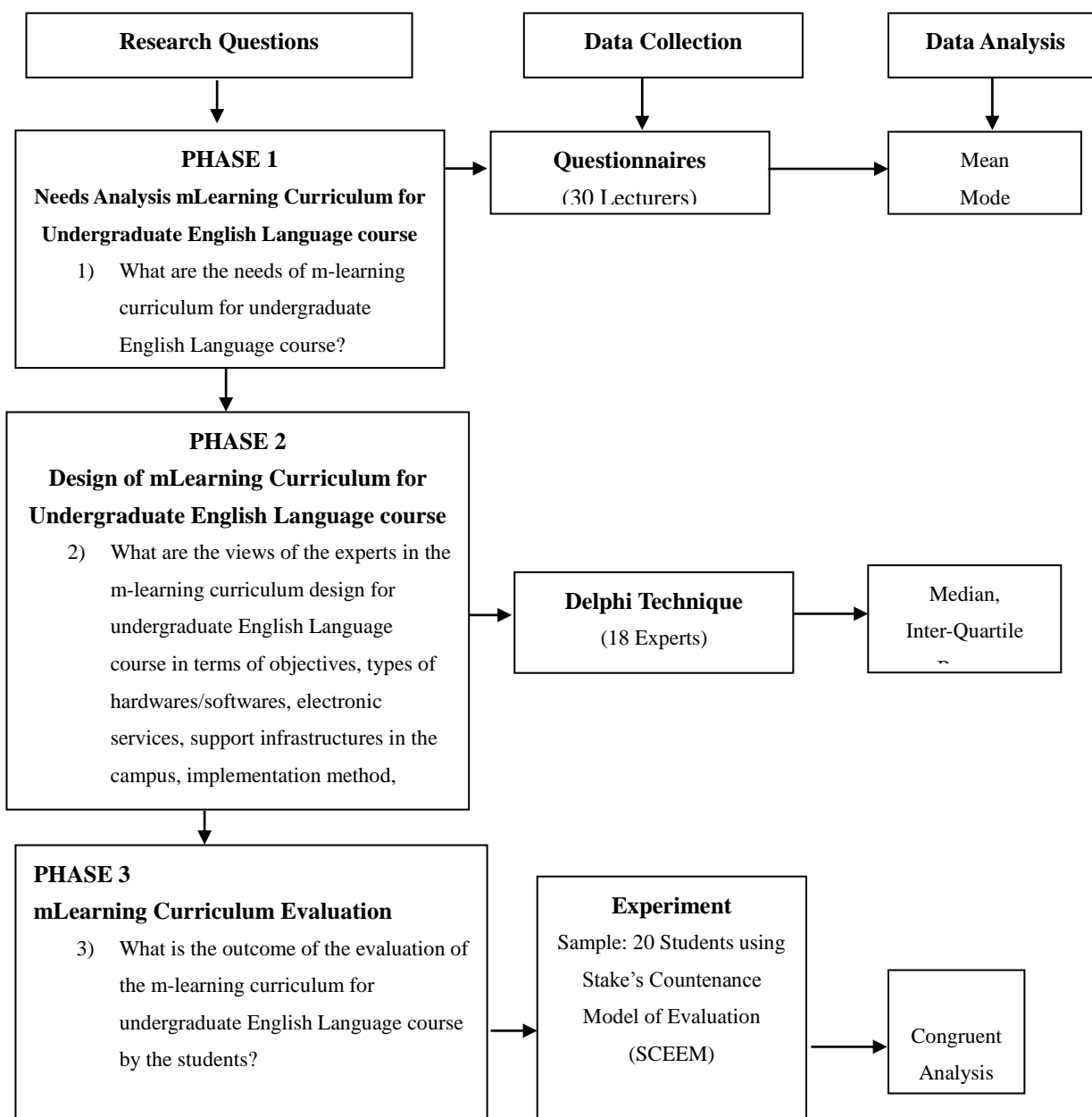
| Research Questions | Data Collection | Data Analysis |

PHASE 1

Needs Analysis mLearning Curriculum for Undergraduate English Language course

1) What are the needs of m-learning curriculum for undergraduate English Language course?

Questionnaires
(30 Lecturers)

Mean
Mode

PHASE 2

Design of mLearning Curriculum for Undergraduate English Language course

2) What are the views of the experts in the m-learning curriculum design for undergraduate English Language course in terms of objectives, types of hardwares/softwares, electronic services, support infrastructures in the campus, implementation method,

Delphi Technique
(18 Experts)

Median,
Inter-Quartile

PHASE 3

mLearning Curriculum Evaluation

3) What is the outcome of the evaluation of the m-learning curriculum for undergraduate English Language course by the students?

Experiment
Sample: 20 Students using Stake's Countenance Model of Evaluation
(SCEEM)

Congruent
Analysis

Figure 1. Methodology Flow Chart

CONCLUSIONS

This study is undertaken as it is relevant to the current as well as future needs of the nation for sustainable education. The decision made by the researcher in selection of the topic to be studied is also based on consideration of niche research areas in education especially pertaining to technology-enhanced innovation in higher education. Based on the discussion here, it is important for the education stakeholders and the government to consider the high possibility of m-learning as learning of the future and thus be well prepared to brace the impact of this emerging learning mode to our country. As mentioned in this proposal, under the influence of technology, the world's society has shifted from online networked society to mobile network society due to the rapid flooding of mobile communication devices and gadgets especially to the younger generation. This resulted in concern educationists and researchers all over the world in initiation of discussion of mobile learning as the next revolution of learning which led to numerous small to large but isolated mobile learning projects. It is a matter of time before mobile learning will be included in the mainstream education throughout the world. However, as m-learning is still new in the literature, there are a number of unsettling issues hovering this new learning mode. Among them would be the ongoing debate of how m-learning should be conceptualized, defined, managed and assessed. While

these issues dominate the literature, there is scarce reference to curriculum design of m-learning. Thus in this study, the researcher decide to commit to the m-learning curriculum design specifically for undergraduate English Language learning.

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PART III: PANEL
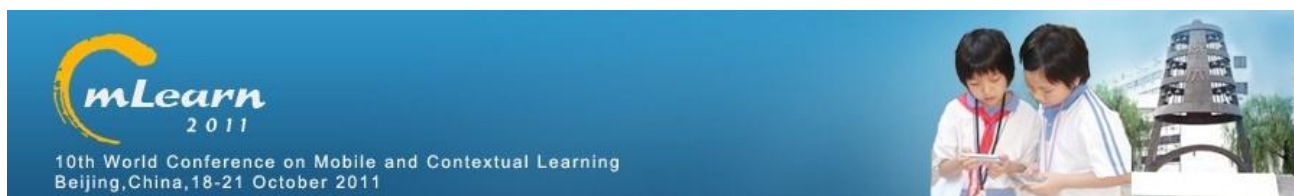
Implementing Mobile Learning Across Cultures Globally: Opportunities and Challenges

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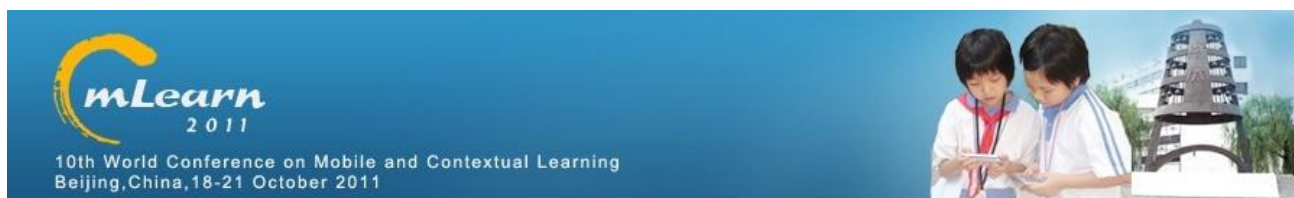**Yen-Lu Chow**
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ABSTRACT

Because of the rapid growth in the use of mobile technology globally, there is the potential to reach learners around the world to help them become more educated and to improve the quality of life. Mobile technology allows citizens, many of whom are underserved, to access both formal and informal education using their existing technology. There are many global initiatives to help people around the world achieve a basic educational level. For example, one of the United Nations Millennium Development Goals is to achieve universal primary education by 2015. One important strategy to achieve the Millennium Development Goals is to design and deliver learning materials using mobile technology since many people already have mobile devices. Another important reason to deliver learning materials on mobile technology is because in some developing countries, a large percent of the population is young people who will be the next generation of students. The current and future generations of students are very comfortable using mobile technology and they expect that mobile technology will be used in the learning process. This diverse panel, which consists of mobile experts, has global experience in the implementation of mobile learning using mobile technology, including smartphones and tablets. They will describe global mobile learning projects and discuss opportunities and challenges when implementing mobile learning projects globally.

Author Keywords

mobile learning, global learning, mobile technology

Role of context in mobile and ubiquitous learning: What do we want to know about our students?

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ABSTRACT

The panel seeks to examine the role of context in various multi-dimensional learning processes in mobile and ubiquitous learning environments and aims to identify what students' characteristics play dominant role for effective learning.

Author Keywords

Mobile and ubiquitous learning, Context, Discourse analysis, Authentic learning

INTRODUCTION

Use of mobile and sensor technologies in learning has emerged as a growing research area, and has given rise to a lot of research that takes advantage of learners' location, environment, proximity and situation to contextualizing the learning process. The adaptivity and personalization in these scenarios have taken a new meaning by bringing authentic learning much closer to holistic learning by seamlessly integrating physical objects available in the learner's vicinity with virtual information in real-time, and enabling more effective discourse analysis in computer supported collaborative learning in such mobile and ubiquitous environments.

Such mobile and ubiquitous environments not only break the barriers for education by widening the access to those who cannot come to a physical classroom but also increase the richness of the instruction by integrating multiple sources of instruction, contextualization and real-time location-aware learning, hence overcoming the limitations of classroom learning. The consideration of context enables creation and use of situational problem-solving scenarios, use of highly individualized examples and cases, real-time identification and use of physical objects from students' environment to explain complex concepts, and creation of highly creative collaborative tasks that exploit different contexts of students taking part in computer supported collaborative learning whether at the same place or from different geographical locations. Consideration of multiple contexts for distributed students also has potential to increase richness of discourse analysis by enabling inclusion of multiple perspectives, multiple experiences and multiple situations within a particular collaborative learning process.

Effective application of pedagogy and facilitation of learning process in such environments demand special considerations not typically required in a classroom setting. The scope of context varies as the learning process progresses from simplistic scenarios to more complex concepts and from individualized learning to computer supported collaborative learning. This panel will examine the role of context in these multi-dimensional learning processes and to identify what students' characteristics play dominant role for effective learning. Using various concrete examples from their own research and instruction, panellists will put forward their perspectives and interact with the audience with the

aim to develop various directions of existing understanding of the area and emerging directions as the way forward for future research.

ACKNOWLEDGMENTS

PART IV: PRE-CONFERENCE WORKSHOP

New Forms of Application and Development of handheld digital equipments in teaching and learning

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ABSTRACT

With the development of handheld digital technology, more and more handheld digital equipments have been applied into different subjects teaching and learning. It provides learners with a one-to-one learning environment which makes learning more ubiquitous, portable, and personalized. How to construct, exploit and use this handheld digital learning environment become the hot topics in the study of current 'one-to-one' learning, mobile learning and ubiquitous leaning. This workshop seeks to experiences, questions and developing trend of integrating handheld digital equipments into different curriculums and different learning activities, including learning resource design, learning environment construction, application model construction and practising strategies production in different curriculums.

Author Keywords

handheld digital equipment, one-to-one learning, integration, course

INTENDED AUDIENCE

Mobile learning designers, researchers, teachers with an interest in designing and practising mobile learning.

INTRODUCTION

With the development of mobile computing and internet technologies, more and more handheld digital equipments are developed and introduced to education, such as small tablet computer, handheld learning machine, handheld Graphing Calculator, PDA, etc. All of them make learning in or out class become more and more ubiquitous, portable, and personalized. However, how to construct, exploit and use this handheld digital learning environment become the hot topics in the study of current 'one-to-one' learning, mobile learning and ubiquitous leaning. With the development of research, we find one of the key of improving the effectiveness of the handheld digital learning is to promote the deep integration of handheld digital equipments into teaching and learning in different curriculums, which involve learning resource design, learning environment construction, application model construction and practising strategies production, etc. All these topics around courses application of handheld digital equipments will be worth to discuss which will be beneficial for the development of the research and practice.

WORKSHOP GOAL

This workshop seeks to experiences, questions and developing trend of integrating handheld digital equipments into different curriculums and different learning activities, including learning resource design, learning environment construction, application model construction and practising strategies production in different curriculums.

WORKSHOP TOTAL TIME

This workshop will last for 2 hours approximately.
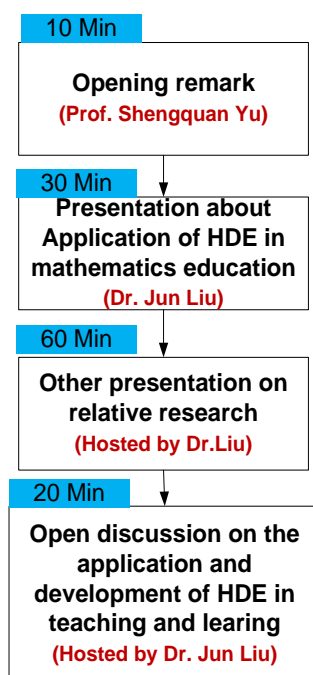
WORKSHOP OUTLINE

Figure 1. Outline of the workshop.

The workshop will be organized as shown in figure 1. First of all, Professor Shengquan Yu, who is the conference chair of mLearn 2011 from Beijing Normal University, and a well-known scholar in the area of u-Learning, will give an short opening remark lasting about 10 min on the current state of handheld digital learning research.

Followed the opening remark, Jun Liu, who was the head of handheld learning group in the institute of modern educational technology of Beijing Normal University, now is working in the department of educational technology of Capital Normal University, will give an presentation last about 30 min about the study of integration handheld digital equipments into mathematics education. Our research materials have been published on the web, and the web address is http://www.etc.edu.cn/手持式课题指导站/index.htm .

After the presentation above, there will be other presentation on relative research.

At last, there will be an opening discussion lasting for 20 min, hosted by Dr. Liu, on the new application of integration handheld digital equipments into curriculum. All the participants will be inspired to deliver their points of view, and to engage in the open discussion.   It is expected to inspire more sparkle on the application of integration handheld digital equipments into curriculum.

SHORT BIOS OF WORKSHOP PROPOSERS

Prof. Shengquan Yu is Dean of School of Educational Technology in Beijing Normal University (BNU), in which educational technology is one of the National Key Subjects. He is also the conference chair of mLearn 2011. He has published more than 140 papers in referred journals, international conferences, newspapers, etc. In addition, he has accompished and engaged about 40 research projects. In recent years, he engaged in digital learning and had many relative projects and research achievements, especially mobile learning. More detailed information is available here: http://www.etc.edu.cn/yusq/yu_sheng_quan.html.

Dr. Jun Liu graduated from the department of modern educational technology in Beijing Normal University, and was also the head of m-learning group in Beijing Normal University, and led a team with 10 members, now, as a teacher of department of educational technology of Capital Normal University, whose research interest are 'one to one' digital learning, mobile learning, integration information technology into curriculum. She has published 18 academic papers in various journals and international conferences.

When Less is More: Exploring Accessible, Affordable,

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Open-Source M-Learning

This hands-on workshop invites participants to explore mobile learning at its most affordable, open-source, and platform –universal.

During the first of three parts, workshop leaders Lucy Haagen (Duke University, US) and John Eyles (Urban Planet Mobile, New Zealand) will provide hands-on training in the use of smartphones repurposed as "Mobies," offline platforms for students to access, produce and share multimedia content that is engaging, interactive, and educational. Using devices provided in the workshop, participants will learn how to develop an open source, multimedia m-library that serves as the basis for lessons adapted to learners of different abilities and learning preferences. Participants will also learn to use Bluetooth as a cost-free solution for content exchange and messaging within a classroom.

During the second part of the workshop, participants will sample an award-winning text & audio language learning program delivered via SMS and ringtone technology. They will also learn about other SMS-based mlearning applications proving effective for teacher training, literacy and health education.

The workshop will conclude with group discussion of a proposal to collaboratively develop a global open-source m-library. Participants will explore the viability of a digital asset repository, with contents chosen, formatted, and organized to meet the needs of teachers and learners using different mobile platforms.

The workshop will be grounded in the practical experience of Lucy and John with m-learning programs in under-resourced environments including a literacy initiative in South African middle schools, Academic English for low-income urban and rural high schoolers in North Carolina, and Basic English for adults in Indonesia. Handouts will include summaries of relevant research and an M-Learning Lite resource list.

John Eyles is an internationally recognized educator and innovator who currently overseas curriculum and pedagogy for Urban Planet Mobile, a global, mobile education provider and winner of the 2011 GSMA award for Best Mobile Education Application. He is founder of English to Go, one of the first and largest web-based English learning portals. John has worked as Research and Alliances Leader for Telecom, NZ taught in universities around the world including Auckland (NZ), Cambridge (UK), Waseda (JP), and consulted for media and technology companies including the BBC, Mubadala Learning Media, and Omnitec.   John holds an M.A. from Auckland University of Technology (NZ).

Lucy Haagen is an English educator with a special commitment to using digital technologies to empower under-resourced communities of teachers and learners. She is currently a lecturer in Duke University's Program in Education where she offers "service learning" courses through which college students teach literacy and English to marginalized adult and adolescent learners. Lucy also directs M-learning projects in the U.S. and S. Africa and has provided hands-on M-learning workshops for teachers in Vietnam, Tunisia, S. Africa and North Carolina. Lucy holds an M.A. from the University of Sussex (U.K)

New Forms of Learning Resource for Ubiquitous Learning

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ABSTRACT

Ubiquitous learning has become the future way of learning. Current researches on ubiquitous learning mainly focus on the construction of conceptual models and supporting environments. However, how to organize learning resources to satisfy the needs of anytime, anywhere, on demand and adaptive learning is an emerging problem. This workshop seeks to identify the specific features of u-Learning resource, and to explore the adpative organizational model of learning resource within the context of u-Learning.

Author Keywords

Ubiquitous learning, learning resource, organizational model, learning cell

INTENDED AUDIENCE

Mobile learning resource designers, ubiquitious learning researchers, LMS providers with an interest in u-Learning environment. Require basic knowledge in e-Learning or m-Learning resource design. It would be best to have a foundation of learning technology standards, such as SCORM, IMS-LD, IMS-CC and so on.

INTRODUCTION

With the development of pervasive computing and Internet technologies, information space will be blended with physical space seamlessly to form a ubiquitous information space combing reality with fantasy. All of them make learning become more and more ubiquitous, which means learning happens anytime, anywhere and on demand. Current researches on ubiquitous learning (u-Learning) mainly focus on the construction of conceptual models and supporting environments. However, how to organize learning resources to satisfy the needs of anytime, anywhere, on demand and adaptive learning is an emerging problem. Current learning technologies concern with learning resources sharing in a closed structure, which neglect the sustainable development and evolutionary capability of learning resources, the dynamic and generative connections between learning resources as well as between learners and teachers.

WORKSHOP GOAL

This workshop seeks to identify the specific features of u-Learning resource, and to explore the adpative organizational model of learning resource within the context of u-Learning. Audiences will know a new form of learning resource for u-Learning named Learning Cell, and get a compeletely fresh understanding of future learning resource design.

WORKSHOP TOTAL TIME

This workshop will last for 2 hours approximately.
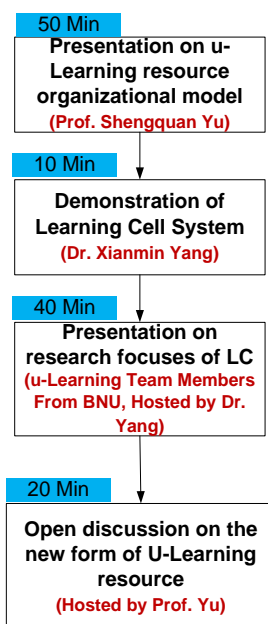
WORKSHOP OUTLINE

Figure 2. Outline of the workshop.

The workshop will be organized as shown in figure 1. First of all, Professor Shengquan Yu, who is the conference chair of mLearn 2011 from Beijing Normal University, and a well-known scholar in the area of u-Learning, will give a presentation entitled "Learning Resource Design and Sharing in Ubiquitous Learning Environment" lasting for 50 min. In this presentation, he will introduce a new resource organizational model named Learning Cell (LC) to the audiences, and stressly explain the design concept of LC, the runtime environment of of LC, the conceptual and information model of LC, and finally the possible application scenarios of LC.

The good news is that the prototype system of LC has been published on the web, and the web address is http://lcell.bnu.edu.cn. Followed Prof. Yu's presentation, Xianmin Yang, who is the head of u-Learning group in the institute of modern educational technology of Beijing Normal University, will give a demonstration of Learning Cell System briefly lasting for 10 min. It will help the audiences to understand LC more intuitively.

After the demonstration above, there will be a team presentation on current reseach focuses of LC during which some key members in u-Learning group from Beijing Normal University will present their works based on LC one by one lasting for 40min. Research works include the orderly evolution of u-Learning resources, personalized recommendation of u-learning resource, design of visual interpersonal knowledge cloud, self-adaption of learning content on multi-devices and design of educative resource template to promote student learning.

At last, there will be an openning discussion lasting for 20 min, hosted by Prof. Yu, on the new form of u-Learning resource. All the participants will be inspired to deliver their points of view, and to engage in the open discussion. It is expected to inspire more sparkle on the design of u-Learning resource, and to identify what actual kind of learning resource is most suitable for u-Learning.

SHORT BIOS OF WORKSHOP PROPOSERS

Shengquan Yu is a professor and dean of School of Educational Technology in Beijing Normal University (BNU), in which educational technology is one of the National Key Subjects. He is also the conference chair of mLearn 2011. He has published more than 140 papers in referred journals, international conferences, newspapers, etc. In addition, he has accomplised and engaged about 40 research projects. At present, he is undertaking a key program funded by the National Natural Science Foundation of China, which aims to explore the organizational model and key technologies of u-Learning resource. His recent researches focus on u-Learning, learning management system, educational informationization, standards of learning technology, etc. In 2009, he firstly proposed the concept of Learning Cell, and opened up the door of

studying of u-Learning resource design and share. More detailed information is available here: http://www.etc.edu.cn/yusq/yu_sheng_quan.html.

Xianmin Yang is a Ph.D student, majored in educational technology in Beijing Normal University (BNU). He is one of the designers of Learning Cell, and has published 18 academic papers in various journals and international conferences. He has also engaged in more than 10 projects, including 3 National longitudinal projects and 7 horizontal projects which is cooprated with companies. He is also the head of u-Learning group in Beijing Normal University, and leads a team with 15 members. Find more information on his personal website: http://lcell.bnu.edu.cn/TeamMember/Yang/cv-en.html.

Researching How Networked Mobile Devices Enable Experiential Multimedia Learning

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ABSTRACT

Today using networked mobiles everyone can be a global producer and distributor, not just a consumer, of text, image, audio, video and multimedia. The affordance of mobiles for producing no-to-low cost multimedia is enabling rapid change in the way we know the world and thus how we think, learn, create, represent and communicate knowledge. How can the affordances of mobiles enhance student engagement, participation and learning? Participants discuss why theories of experiential learning are important when designing effective mlearning strategies and why digital multimedia literacy is an emerging important issue in university education.

Our focus is on Kolb's (1985) theory of experiential learning and Itin's (1999) concept of experiential transactions between student and teacher. We discuss the Facilitator's recent investigations of using mobiles to improve interactivity in learning spaces, vodcasting as a collaborative team assignment, and enhancing fieldwork tasks with multimedia data collection. We discuss how other experiential learning strategies can be enabled by mobile devices. Workshop participants discuss and identify their preferred experiential mlearning research direction/s and form potential international project teams.

Author Keywords

mobile-learning, experiential-learning-theory, multimedia-literacy, curriculum-design-renewal, multimedia-student-learning-activities, student-engagement, educational-technology,

WORKSHOP AIMS AND OBJECTIVES

This Workshop aims to examine and identify questions and directions for researching sustainable, experiential, multimedia learning enabled by networked mobile devices. We will identify experiential learning strategies that can be enabled by mobile devices and discuss the emerging important issue of multimedia literacy in university education. Many interesting research questions arise and are identified and discussed. The Workshop ends with participants forming initial international collaborative research teams.

By the completion of the Workshop participants will be able to;

1. Understand the importance of sustainable, experiential, multimedia approaches for improving learning outcomes,

2. Identify experiential learning activities that use mobiles to improve student engagement,

3. Use the no-to-low cost *minteract™* online tool to improve engagement and feedback in learning spaces,

4. Integrate student-generated *vodcasts* and *screencasts* into their teaching practice,

5. Integrate learnert-centred multimedia *fieldwork* into their teaching practice,

6. Identify their preferred experiential multimedia mlearning research interests,

7. Form initial international research teams with other Workshop participants.

Intended audience (experience level and prerequisites)

mLearn2011 delegates who are interested in mlearning research, design and development projects. No prior experience is required though enthusiasm for mlearning is expected.

TOPICAL OUTLINE OF THE CONTENT

1. After introductions we use and discuss *minteract*™ an online tool developed by the Facilitator to support sustainable experiential learning in learning spaces connected to the internet. At no-to-low cost, and more versatile than commercial clickers, minteract is a WAP online application that allows students to use their mobile device to make learning more interactive, experiential and engaging (Litchfield, Raban, Dyson, Leigh, & Tyler, 2009).

2. We discuss why theories of experiential learning enhance mlearning strategies and practices (Dyson, Litchfield, Lawrence, Raban & Leijdekkers, 2009).

3. The Facilitator showcases the outstanding learning outcomes achieved in his recent investigations into improving interactivity in learning spaces, student-generated *vodcasts* and *screencasts*, and *fieldwork* enabled by mobile devices (Litchfield, Dyson, Wright, Pradhan & Courtille, 2010).

4. We identify questions and discuss researching experiential, multimedia mlearning (Dyson, Litchfield & Raban, 2010).

5. Using their mobile devices Participant's in small groups produce a short multimedia presentation about experiential mlearning research directions identified by the Facilitator (Litchfield, Dyson, Lawrence & Zmijewska, 2007).

6. After a plenary discussion of the multimedia presentations Participants discuss and identify their preferred mlearning research direction/s.

7. Based on their identified interests Participants form potential international mlearning research teams and commence collaboration with other workshop participants.

FACILITATOR DETAILS

Andrew Litchfield is a Senior Lecturer in the Faculty of Engineering and Information Technology at the University of Technology Sydney and co-ordinates the Technology and Education Design and Development Research Group. His research interests include; sustainable experiential mobile learning, professional attributes and curriculum renewal, designing multimedia learning resources and the diffusion of educational innovation. Andrew's teaching practice focuses on postgraduate IT professional attributes and academic staff development to improve learning and teaching including curriculum and subject design. He has been responsible for successful national, university-wide and local-area academic staff development and capacity-building projects in using innovative ICT in learning and teaching. This work has received professional media and academic awards.

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PART V: POSTER

(Papers in this part include only abstract, full paper included in the disc.)

A Context-Aware Chinese Poetry Recommender System

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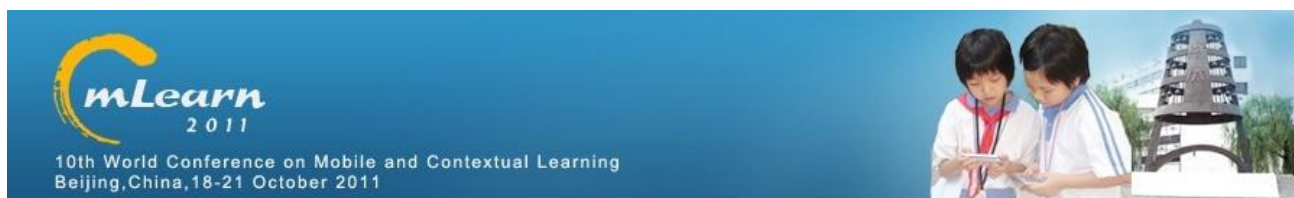Science and Applications, Asia
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With the rapid growth of network technologies, ubiquitous learning becomes popular than ever before. For example, it is possible for people to learn or browse poetry by using handheld devices with wireless communication in an authentic learning environment. In this paper, we proposed a context-aware recommendation system so as to facilitate Chinese poetry study for students. The system contains context acquisition and Chinese poetry recommendation. The acquisition involves sensor data collection, context augmentation and poetry style reasoning. The context augmentation is to augment sensor data mainly by using associative words. The associative words can be obtained from the tagged resources in the application of Web 2.0, for instance, flickr related tag browser. With the aid of context acquisition mechanism, salient context (e.g., user context, surrounding context, poetry style) is acquired in the way of a context-aware dialogue. The proposed recommendation is constructed on the computation of the semantic distance between poetic content and salient context by the employment of an external ontology. In the last, the system performance is verified on a real experiment conducted by 30 invited university students. The evaluation criterion is built on the basis of user's click information and is measured in terms of Top-N inclusion rate and Mean Reciprocal Rank (MRR). The experimental results show that Top-5 inclusion rate is 0.93 and MRR is 0.55, indicating this system can assist users in finding out appropriate poems. In addition, 3.98 Satisfaction (out of five-point Likert scale) is achieved from the collected 30 satisfaction questionnaires (containing six items), proving that the proposed system is indeed helpful for users to retrieve appropriate poems with respect to their queries.

A Design Research Approach to Mobile Learning

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Researchers are calling for more design theory for mobile learning. The majority of mobile learning research describes mobile learning in a specific context, and does not seek to determine how best to design and teach using mobile technology (Koszalka & Ntloedibe-Kuswani, 2010, p. 141).

Design research provides a solution to a real-world educational problem and adds to educational theory in the form of design principles that can be used by educational practitioners (Brown, 1992, p. 143). Design-base research is "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Wang and Hannafin, 2005, p. 6). Since design research is intended to both solve a real world problem and to develop re-usable design principles, it is well suited to help develop needed design theories for mobile learning.

Most mobile learning projects involve both instructional designers and software developers; therefore, a design research approach to mobile learning should take into account the process used by these practitioners: specifically, an ADDIE-based instructional design approach and an Agile-based software development approach.

There are many approaches to design research - all of which begin with a theory gathering or literature review phase and end with a reflection on both the design solution and the design research process. The middle part of the process - the iterative cycles of analysis, design, development, and implementation - very among the different approaches.

For mobile learning content design, I recommend a simplified four-phased design research approach that draws on the characteristics of the design research approaches presented in research with instructional design methodologies and the agile software development method. I call this approach ASER (analyze, strategize, experiment, reflect). As illustrated below, the ASER process has four phases: 1) analyze real-world problem, 2) strategize design experiment, 3) conduct context specific design experiment, and 4) reflect on entire project.

The experiment phase, has an inner loop of Design, Develop, Instructional Experiment, and Evaluate, and can be adjusted to reflect the size of the project. Unlike classroom-based design research, short mobile learning modules (under 20 minutes of content) allow researchers to iterate through multiple cycles in a single research project, thereby adding significant contributions to design principles in a timely manner.

Jwest: A Career Support System with a Fundamental Cooperation between Students, Professors, and Career Office staff

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ABSTRACT

This paper describes a career support Web system (Jwest), which was developed in order to help our university place students on a career path. Jwest keeps two kinds of records of each student: activity record and job hunting record. These files include the courses they took, their scores, extracurricular activities, and their job hunting experience (applications, examinations, interviews, results, etc.). Through a PC or their cellular phone, students can record their extracurricular activities (on and off campus) of their job hunting experience on Jwest. Jwest keeps professors and the career office updated on the job hunting situation of each student. Allowing professors and career office staff to provide proper support, advice and introducing suitable career path to the student.

Enhancing Motivation by using Story Manga

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In this paper, I have developed the mobile phone learning system using manga story based. This system was focused on assisting of students for self-regulation learning. SRL that stand for SRL students learn proactively to evaluate their learning results by themselves. I propose the application of SRL to e-learning I have used the based on these create educational manga story. I could survey and show216 students six pages of an educational manga story mobile phone and asked. The survey results make it clear that an educational manga story the contents more creativity and keep student's motivation of learning high, interest and encourage learning through fun and easy understanding and interactions. However, they are not used the mobile phone is unpopular. This is the evaluation results of the manga based e-learning content for a mobile phone by questionnaires to 40 students that the number of learners with satisfaction is not /enough large, The possible reasons for this bad evaluation are the small size of display, Separated manga frame which suppress the empathy, and maybe expensive date transfer cost. This is the same manga based e-learning content for a mobile phones Since the display size of the mobile phone is limited to 210 by 144 pixls an additional function to present the manga content by each manga frame is implemented by using WebClass ver.9.03.The manga based e-learning content for mobile phones has other disadvantages. When the mobile phone does not provide a full browser function, WebClass is not available.

Mobile Learning: Delivering French Using Mobile Devices

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Use of mobile learning in education is one way to reduce barriers to learning. Allowing students to choose their means and mode of course delivery can eliminate geographical and physical barriers that have prevented students from accessing course materials presented in a more traditional classroom manner. A research project that investigated the use of mobile technology to teach French was conducted. Five interactive lessons teaching basic French grammar and vocabulary were designed and delivered using iPhones. The subjects looked at the content of an AU-designed French language website through an iPhone; they completed the lessons and provided feedback through interviews and by answering an extensive questionnaire.

The following guidelines were used to develop the lessons for the mobile training.

1) Chunking the information- this prevents "information overload" when content is divided and presented in smaller, more easily digested pieces. This format caters to mobile devices and learning on the go.

2) Use advance organizers to facilitate the processing of details- provide students with a way to link the new information with that which they are already familiar with (can be done with text or graphically).

3) Dual-coding hypothesis- present information in visual and textual/verbal, so that different styles of learning are addressed and more students have different triggers for processing and retaining the information.

4) Use concept and information maps- this allows students to quickly grasp the point and direction of a lesson without a lengthy text explanation.

5) Design for specific context- targeting lessons in specific contexts (i.e. workplace situations), makes the lessons relevant and interesting to students.

Testing took place in a single day with two groups of eleven volunteers (twenty-two in total) each participating in one three-hour French mobile training session. The volunteers were required to fill out a short (eight question) paper-based, multiple choice quiz testing their knowledge of basic French at the start of the session. This test was then repeated following language training with the iPhone. The results, from these pre- and post-training tests, were later checked to see if the training resulted in improved scores.

Overall, students who participated in this study found the format and content of the lessons useful. They enjoyed using the iPhone and wanted to take more lessons with this device. Other reactions were a desire for more interactive content, and questions about wireless accessibility with a recommendation toward designing an app that could be used offline. This study will benefit researchers and designers interested in creating language training for delivery on mobile devices.

Interaction Analysis of twitter communication on Problem Based Learning

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ABSTRACT

This study aims to strategically use Micro-blog(Twitter) to build online communication environments for problem-based learning (PBL). PBL is an approach emphasizing students' learning through active inquiry such as to represent problem, associate solution with problems and apply solution with colleagues. Communication is a key element of successful PBL to collaborate effectively with other peoples and to get scaffolding from facilitators. Micro-blogs such as Twitter will be new challenge to expand communication channel and mode. It gives a chance to expand learning from classroom to out of life, and make community member to participate in class as mentors of other younger and less experienced people. I applies twitter as an additional communication tool in PBL class. 3,574 tweets were analyzed to understand communication pattern on twitter. Finally, unique patterns of twitter communication were indentified and measured. The results showed that 1) twitter gives chances learners to report their temporal behavior and emotional mode. It helps to improve social awareness, 2) twitter shows top trending topics by tweet and retweet. It helps to coordinate the process, 3) twitter have drawn dozen of outsiders who has expertise and interest in that topic to the class. It helps to have lined up a member of mentors to facilitate problem solving and integrate in real world, 4) Messages on Twitter contain, to sharing information, to argue each other, to teach each other, to reflect the problem solving process and to help each other.

The Road to Mobile Learning

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ABSTRACT

To meet the needs of students, and fulfill Athabasca University's mission to remove barriers to learning, Athabasca University (AU) Library has initiated a number of mobile learning projects.The poster "Road to Mobile Learning" examines some of the reasons why AU undertook these projects, a brief summary of some of the content, guidelines and features of AU projects, and some of the challenges and opportunities in the future.

There is a new generation of students that are technologically savvy, can adapt to technology, and want to access information quickly. To meet the needs of these students Athabasca University Library has initiated a number of mobile language projects.

The first of these projects was the English as a Second Language project (http://eslau.ca).This project delivered content to very basic mobile devices. The content was mostly text based with few images and no video or audio. Following up on ESLAU, the Workplace English website (http://wpeau.ca) was created in response to feedback on the ESL site. On this site, students are able to access learning resources, in interactive module formats with multimedia rich content (such as text, audio, and video) on demand, with the goal of increasing their motivation and interest while facilitating self-directed study.

The French as a Second Language site (http://fslau.ca), contains lessons, interactive exercises, and audio clips. It was also developed in our Mobile Knowledge Management System (MKMS) which allows for dynamic editing of content. The MKMS was a significant advance as it is now possible for anyone to create a mobile website with little effort and no specialized knowledge.

Future development offers both possibilities and challenges. Devices are becoming much more powerful and capable allowing for full multimedia content. Applications are also a good way of connecting users to content. Unfortunately, applications are fragmented between different devices and developing for all is very expensive.

PART VI: INDUSTRY SHOWCASE
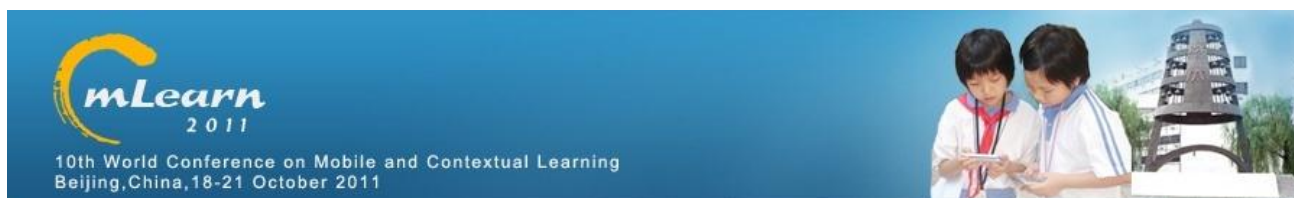
English learning opportunities across mobile technologies, platforms and cultures

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ABSTRACT

The British Council is utilising various mobile technologies to deliver language learning in radically different contexts. By adapting language learning content for delivery via different channels we aim to provide learners and teachers of English with quality language services regardless of location or the type of mobile device they have access to.

Author Keywords

Neil Ballantyne, British Council

DESCRIPTION OF PRODUCTS

The British Council has developed a wide range of content delivered through various mobile products to help learners of English improve their knowledge and command of the language, whatever their reason for learning.

For example, English for Work is a series of courses that provide language training for the workplace with specific focus on tourism, policing, IT and other industries where the use of English is often a requirement and a vehicle for improved employability. These courses have been designed to be delivered in multiple ways – online, through traditional broadcast and via mobile, using a wide range of mobile technologies.

This content has been developed for a global market based on the needs as defined by the countries and regions in which we operate. This content is made available to regions to localise for cultural suitability and deliver via mobile channels dependent on the local market's technical environments. For example 3G video calls will be used in India and SMS is being used to reach rural China on subscription plans. Smartphones and feature phone users are being catered for with products distributed via global app markets and directly from the British Council's websites. Other technologies such as IVR and USSD are being investigated for other delivery opportunities.

Another part of the Council's strategy has seen us shift our attention from developing isolated native apps for smartphones to using a mobile development framework that allows us to build apps for a wider range of phone types and operating systems. We have focused on developing container apps that practice discrete English language skills and systems (such as vocabulary and grammar) and provide access to downloadable content to populate the apps so the user can gain access to the topics and themes that they need.

Different pricing models are in place for the products and content developed by the Council. Container apps are provided for free. Downloadable content is either free of for a nominal fee using in-app purchasing. Subscription services are offered in partnerships with local service providers and content aggregators where revenue is split. We also work in partnerships to

deliver learning opportunities to populations in the developing world that have traditionally been harder to provide access for.

COMPANY DETAILS

The British Council is the united Kingdom's international organisation for cultural and educational relations. Amongst other objectives, we exist to develop a wider knowledge of the English language and otherwise promote the advancement of education. We aim to provide every learner and teacher of English with access to quality language services from the UK. We have offices in over 100 countries and territories and are active in many more.

We have been active in developing mobile learning content for some years and this experience has allowed us to develop a coherent strategy for providing learning opportunities for a wide range of learner groups in different technological environments. We work on a global and local scale using different delivery channels. We work with partners such as Nokia and Intel to deliver language content to schools in the developing world using mobile technologies. We produce successful and popular apps for smartphones and feature phones that utilise the affordances of mobile to provide unique language learning opportunities.

We are a world authority in language learning and bring a unique blend of pedagogical and technical experience to mobile learning development.

PRESENTER DETAILS

Neil Ballantyne is the Mobile Learning Manager for the British Council working as part of a global team developing mobile content and products. Neil has an MA in Digital Technologies, Communication and Education from the University of Manchester where he focused on mobile learning including his dissertation where he managed the development of a vocabulary learning app for the iPhone, MyWordBook. Neil is based in Hong Kong.

The GSMA Mobile Education Project: developing the proposition and business models for mobile education

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What do we mean by Mobile Education?

Mobile Learning takes place when a student uses a portable device, such as a smartphone, netbook or tablet, or handheld gaming device, to access learning materials and systems and/or to interact with other learners and teachers or the environment. It has the advantages of enabling learning to take place at any time in any location, at a pace chosen by the learner whilst providing a personalised and motivating learning experience relevant to location and context. It can be individual and collaborative and transformational.

We use the term **Mobile Education** as an extension of Mobile Learning to provide a broader more inclusive description of the many opportunities mobile technologies and systems offer for improving learning, teaching, assessment and educational administration. Mobile Education incorporates eBooks, learning materials and systems, delivery of the latest material, collaboration, learner/tutor communication, evidence collection, e-portfolios, attendance and marks recording and monitoring, learning tasks planning, curriculum and device management.

Mobile Education takes place in institutions or contexts offering any form of organised or formal education. This includes schools, universities, colleges, adult education and community based learning centres, centres offering professional qualifications, work based learning providers and corporations.

The Mobile Education market landscape

Increasingly, countries around the world are recognising that investment in education is an investment in their future growth and economic prosperity. This comes at a time when mobile connectivity provides the opportunity to offer new ways of teaching and learning that are cost-effective and can create programmes of education that can be better personalised to the needs and location of the individual, thereby improving performance and results.

In most OECD countries annual public expenditure on education represents between 4 and 5% of GDP (OECD 2007). UNESCO estimated overall global expenditure on education to be $2.5 trillion in 2004 and there were 1.4 billion enrolled students in 2008. Economic growth, increasing populations and a rising middle class are all driving demand for education in both developed and emerging economies. The education sector spends a greater percentage of revenue on technology than other industries - 5.5% compared to overall average of 4.2% (Forrester). Global education IT spend was $64.15 billion in 2010, showing 2.5% growth even after the financial crisis (Gartner).

The increasing availability of smartphones, tablets, gaming handsets and other handheld devices is beginning to present a compelling learning platform available to a significant proportion of the education market. In developed economies, the goal of 1:1 ratios for devices to students is increasingly being achieved or exceeded.

There are, however, a number of barriers that have so far slowed the widespread adoption of Mobile Education solutions. These include:

- Device availability
- Content availability
- Safety and security
- Sustainable business models
- Cultural factors
- Appropriate connectivity
- Cross ecosystem stakeholder dialogue

The GSMA Mobile Education project aims to assist in addressing some of these barriers and thus facilitate a faster and more widespread adoption of Mobile Education solutions.

What can mobile operators bring to Mobile Education?

There are a number of skills that organisations in the mobile ecosystem (that is mobile network operators, handset manufacturers, systems and solutions providers) could bring to the Mobile Education market.   These include:

- Experience in building scalable and interoperable ICT systems
- End to end systems development and management expertise, from user experience and device configuration through to network and database management
- Systems support and troubleshooting expertise
- Customer relationship management and billing systems
- Security and user authentication

In addition, many mobile ecosystem organisations enjoy strong brand recognition and trust within targeted communities.

Potential roles for operators in Mobile Education include:

- Mobile Education specific connectivity services
- Device logistics and insurance management
- Mobile Education cloud services
- End to end Mobile Education providers

Partnerships with content providers, device vendors and other organisations will be an important aspect of providing Mobile Education services.

The objectives of the GSMA Mobile Education project
- Understand the landscape, ecosystems and business opportunities in different educational sectors
- Enable cross ecosystem dialogue by bringing the mobile ecosystem together with education sector organisations such as education providers, publishers, education authorities, governments, teachers groups etc.
- Describe and promote the benefits of Mobile Education as part of overall eEducation solutions
- Identify appropriate and sustainable business models for Mobile Education
- Prove the efficacy of delivery of education content over mobile networks
- Build a knowledge base of case studies, lessons learned, best practice and recommendations for Mobile Education solutions

Where have we got to?
- Completed initial landscape studies   http://www.gsmaembeddedmobile.com/mobile-education
- Produced a draft proposition for Mobile Education

Building partnerships between educational institutions, mobile operators and other stakeholders to develop, run and evaluate several pilots
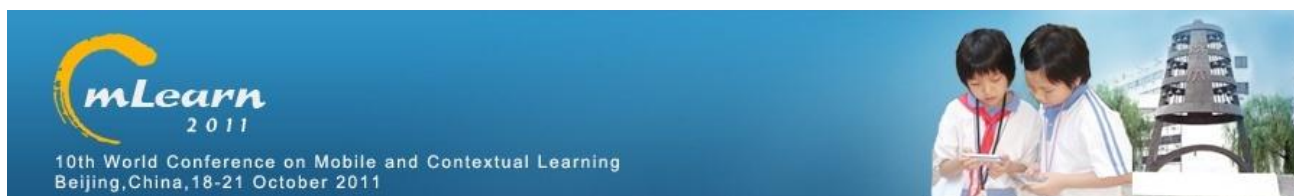
Adapting teaching materials to mobile scenarios in Android and iOS platforms

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ABSTRACT

This showcase summarizes the experience of the Universitat Oberta de Catalunya (UOC) in the adaptation of its web based teaching materials to two common mobile platforms: Android and iOS (Iphone). The paper describes the process for the automated transformation of the existing teaching materials (open content) of the University into applications that can be executed in these mobile phones.

Author Keywords

Opencourseware, OCW, e-learning, Android, Iphone

INTRODUCTION. The university

The UOC is what we call a fully online learning university, meaning that the whole learning system and its services allows students to learn beyond the boundaries of time and space. The UOC is a cross-cutting Catalan university, less than fifteen years old, with a worldwide presence, aware of the diversity of its environment and committed to the capacity of education and culture to effect social change. At the moment the University has 56.000 students and offers 1,907 courses in various master's degree, postgraduate and extension programmes.

The trend to use mobile devices for learning

The huge focus allocated in innovation has allowed UOC to develop powerful technologies in terms of concept and usefulness. The teaching materials are usually the main tool that students use to learn. Along with other online resources, provided or not by the university, we have observed an increase in the number of students that access web materials in mobile scenarios with devices likes Ipads, netbooks, mobile phones, ebooks, etc. For example, common scenarios are when students are far from home, at holidays, when travelling by train, from bars ,etc. Also, at the moment the UOC is offering its virtual learning environment services (but not materials) for mobile devices, being very common for users with ipads or mobile phones to access these services like email, marks, subject forums, teacher spaces, etc. All these facts made us think about developing specific teaching materials that really fit these mobile devices.

More specifically, at the present time we already know that most of our students own　a smartphone, being Iphones and Android phones the most common ones. These devices offer a bigger screen that is more adequate to read for sometime, plus it facilitates the view of images, videos, music and other multimedia elements. According to this context, we decided to also offer proper versions of our teaching materials for Android and iOS devices.

Offering Open teaching materials for mobile scenarios

This time, our strategy has not been to only offer these resources to our own students but to anyone in the world that can be interested to use them. In short, the idea is that teaching materials will be uploaded to the Android market and the Apple Store so that they are available to the owners of these devices. In terms of licensing, this decision has an important impact for us, because only the teaching materials that have an Open License, like Creative Commons Attributive License 2.5, can be freely offered without authoring conflicts. Fortunately, the UOC is part of the Open Content movement and owns an OpenCourseWare portal (check at *www.ocw.uoc.edu*), where course materials that are used in the teaching of undergraduate and graduate subjects are available on the Web, free of charge, to any user anywhere in the world. More than 200 teaching materials in English, Catalan and Spanish are placed in this portal, and so, potentially will be part of the teaching materials offered for iOS and Android. Because technology makes it possible for us to increase the reach of educational opportunity, we have a moral obligation to do so. OCW supports eduCommons's mission to serve the public through learning, discovery, and engagement, and is true to eduCommons's guiding principle that academics come first.

The technology developed

The challenge of this idea was how to be able to create hundreds of teaching materials adapted to iOS and Android without having to develop them from scratch or needing to have a huge work of edition of web teaching materials. In this sense, the Office of Learning Technologies of the UOC took advantage of one of its past developments, the MyWay technology, which is a set of tools that allow the transformation of docbook documents into several outputs like *pdf, epub, mobipocket*, etc. automatically producing several type of outputs (audiomaterials, videomaterials, materials for ebooks, etc.) from our web based materials. Myway is distributed under Open License (GLP) and can be downloaded in the Google code website.

This means that our web based teaching materials, as XML documents, have been easily adapted to Iphone and Android devices through a specific compiler that automatically generates files that are ready to be uploaded to the Android Market and Apple Store, where they will be showed as apps.

This application, the compiler, will allow us to easily create teaching materials for these mobile platforms, saving all the time we would need to create an application for Iphone or Android from scratch and avoiding a complex edition process.

Our teaching materials also follow the guidestyle and behaviors of both Android and Iphone, so that the users of these phones can learn quickly how to use and study the materials. For example, in the following images we can see some of these materials.
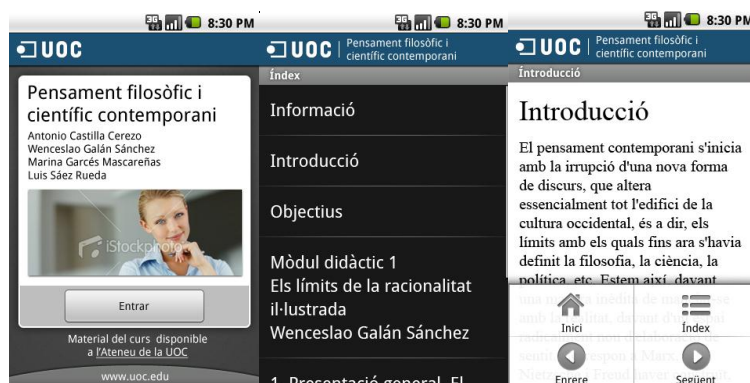

**Figure 1. Example of materials in Android version**

Figure 2. Example of materials in Iphone version

Conclusions and future directions

Mobiles are already at a point where they can not be considered anymore as emerging technology for learning. They are, especially in developed countries, a common technology used with learning purposes, according to most of the e-learning trend reports like the Horizon Report 2011. This scenario requires from Universities to offer most of their contents and resources in a format that students can use from their mobile devices, and to do so, tools like *MyWay* will be necessary in order to automate the process of conversion of University teaching materials in web format into mobile apps. Like in our case, offering these learning resources to the worldwideweb community implies deeper reflections with the authoring rights and the existing open licenses.

For the showcase presentation we will do a few demonstrations on how our technology is able to create Iphone and Android apps (teaching materials) from the web based materials we traditionally offer our students.

PART VII: PRACTITIONER STREAM
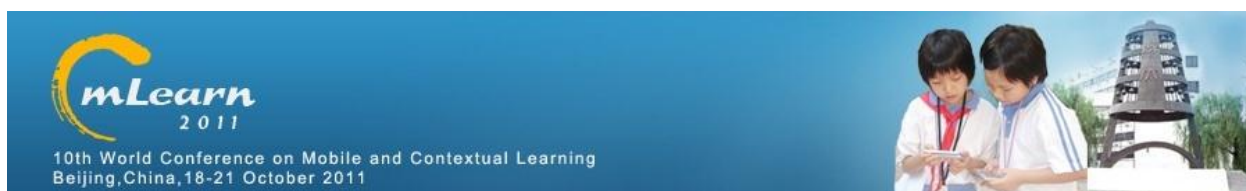
Designing a Global Educational Game Through International Collaboration

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ABSTRACT

In this digital age, there is a shocking absence of digital educational tools for early literacy in languages other than English. Despite the fact that 95% of the world's children are not native English speakers, the majority of them are being educated in English. In this era of contextual learning, teaching children to read in their native language will not only narrow the digital language divide, but also promote cultural sustainability.

Leaders and project managers often fail to see cultural differences for what they truly are: catalysts for creation, innovation and collaboration. iLearn4Free is a US-based non-profit organization with roots in Europe, founded upon the discovery that there is a lack of linguistically diverse digital educational tools. It is our mission to bridge the digital language divide and support cultural sustainability by creating educational applications for mobile phones in multiple languages.

Our main challenge was to create an application that is adaptable to, and accessible by, a multitude of languages and cultures, while keeping costs at a minimum.

While universal design is, to a certain extent, a utopia, we believe that it is the only way to bring the cost down and enable more children to have access to digital learning in their own language. To achieve this extraordinary goal, we have developed an application template with a team of writers, designers and educators from many different nationalities; most of the work was performed through online collaboration.

Author Keywords

Digital, Education, literacy, game

INTRODUCTION

With digital media and tools becoming prevalent in both education and entertainment for individuals of all ages, the availability of digital early learning tools in languages other than English is surprisingly low to non-existent. Digital learning can be a valuable means of providing children across the globe with easily accessible educational opportunities, and yet it remains —for the most part— untapped.

Language is the backbone of every society, but many of the world's children who are not native English speakers are being taught in English. However, the implementation of easily accessible global education tools can turn around this loss of language and culture. Digital learning provides the perfect opportunity for non-native English speaking children to gain literacy in their native language.

I founded the non-profit organization iLearn4Free with the idea of supporting linguistic diversity and cultural sustainability by creating educational early-learning literacy applications in multiple languages. Our application, m4read, is a mobile phone app that teaches children how to read in their native language through interactive games. M4read also invites children to embrace cultural diversity by providing them with stories and learning games set in different cultures.

I believe that the cultural diversity of our team has enabled us to get the best results; indeed a truly diverse team fosters creativity. I have also tried to find ways to encourage collaborative behaviors in an intercultural context, and have successfully overcome the problems one can be faced with in such a unique environment.

LANGUAGE

The first challenge one might encounter in an international collaborative project is language.

WRITTEN COMMUNICATION

One way to limit misunderstandings within a multi-linguistic team is to privilege written over verbal communication. With written communication, team members are given the opportunity to read proposals again and try to understand them fully, which diminishes the likelihood of immediate, impulsive reactions, often due to poor understanding of the given language.

NATIVE LANGUAGE USAGE

Another way to ease communication is to let people express themselves in their native language if they feel more comfortable. I have done this successfully with the Argentinean graphic designer who developed the flash simulation of our mobile games. He preferred to write to me in Spanish, and while I answered in English, it saved him a lot of time and energy.

PROJECT MANAGEMENT SOFTWARE

Using Basecamp™ — or any another online project management software — is also very helpful, as it allows for an open dialogue; anyone can view anybody's input. If two people had to discuss something in their own language, it was also acceptable. Sometimes participants would lose focus on the project and start talking about their lives as mothers or artists. This was actually encouraged, as it enabled a connection between them beyond words and cultures.

CULTURAL DIFFERENCES

Despite what many may believe, language is not necessarily the biggest issue in cross-cultural communication. As people from different cultural groups work together, values sometimes conflict. When we don't understand each other, we sometimes react in ways that make a partnership ineffective. Often we are not aware that cultural differences are the root of miscommunication.

TOLERANCE, TRUST AND OPEN RELATIONSHIPS

Personally, I believe that the key tools for enabling a cross-cultural team to work effectively are tolerance, respect and a willingness to understand and accept each other. I believe that, if you understand other cultures, you can decode behavioral patterns instinctively and avoid criticism and defamation, thus allowing you to move toward a creative pattern. In an environment where trust prevails, it is easier to accept and encourage disagreement, which is a major source of inspiration and creativity.

KEEP IT SIMPLE

One of the key rules we have also tried to apply is to keep communication simple and explicit: we avoid elaborate explanations, which can be misunderstood because of cultural or language issues. We also encourage team members to discuss ideas without focusing on the way the idea is expressed; spelling and grammatical mistake are to be overlooked.

When brainstorming on a specific topic, we avoid reading the ideas of others before giving our input. This way, we will not try to see how our idea competes with others, or change our original opinion based on someone else's. As the leader, I also try to be the last one to give my input, so that nobody is under the impression that they need to agree with me.

KEEP THE PURPOSE IN MIND

Another very efficient way to help run an online intercultural project is to make sure that everyone shares the same global vision. I was fortunate enough to have been able to participate in a contest organized by TED, whose challenge was to create an "Ad Worth Spreading." My team created an advertisement conveying our vision in a visual and symbolic manner, allowing it to have a much greater impact by resonating with the viewer and giving the project a real sense of meaning.

A GLOBAL SCALE

Creating a literacy app that is global might sound unrealistic, because it might be hard to imagine any common pattern between English and, say, Papiamento. Yet, the collaboration between educational experts from different linguistic backgrounds has enabled us to define many commonalities in the learning process. The 18 games we have designed can fit different linguistic patterns; some games may hardly be used in one language, while being very useful in another.

When first designing the application, we realized that it was important to be culturally neutral to enable a worldwide deployment. Therefore, we made the deliberate decision to integrate cultural diversity by using six stories with six different international characters. These stories give context to the application and educational games.

Creating a core template enables our application to be financially sustainable for the following reasons:
1. The mobile market changes so fast that an app quickly becomes technologically outdated, and this makes the importance of a swift development more prevalent than in other markets.
2. Many of the languages spoken by a small population cannot financially support the development of a digital application specific to their language.

A SPECIFIC LINGUISTIC APPROACH

While our general template is not customizable to each particular language (the games, main stories and graphics are shared), the educational content is always tailored to the specific language the app is developed for. Each educational team creates its own learning structure depending on the language, and each unit is illustrated by a mini story that is written by children's book authors who are native speakers.

STRUCTURED PROCESS

Following a very structured process has enabled us to be very efficient, and it provides the team of writers, graphic designers and educators with a sense of comfort and security, which is important in the context of total virtual teamwork. They are being guided through the process, allowing them to move swiftly through the construction of the app.
1. Build a learning structure (curriculum), which consists of about 30 units, each one teaching a specific skill or sound.
2. Collect a list of words that best represent the lesson taught, and then choose 3 games per unit among the 18 educational games available.
3. For each game, choose words that will be used in the learning process and that best illustrate the skill taught in the unit.
4. Write a short story to enable the child to playfully practice the skills learned in each unit.

UNIVERSAL DESIGN FOR MOBILE LEARNING

While an international collaborative approach is not specific to mobile learning, I believe that it is especially valuable in this context. Because mobile learning can make such a difference in the educational world, we need to find a way to include cultural diversity from the start, instead of developing applications in English for English speakers and then

wonder whether it could eventually work for the rest of the world. Universal design may be a utopia, but we need to give it a try in order to bring the cost down and enable more children to have access to digital learning in their own language.

Mobile learning also makes the pilot process really easy, as it take less than one minute to download a new version of an app using testflight. Because of this, the feedback loop can be accelerated significantly, and the development of mobile educational tools can be much faster than the creation of traditional learning programs. The method we use is based on iteration of design: we purposely do not perform extensive (and expensive) research, but we modify our design based on what we experience. In addition, we have thoroughly studied expert sources, such as PBS Kids or Hooked on Phonics, who have over 20 years of experience in teaching through games.

CONCLUSION

I believe that a multi-cultural team is the best asset in trying to find the right balance between global generalization and local specificity, particularly in the context of digital education tools: culturally diverse education experts offer the local insight necessary to ensure the quality of the mobile learning experience for the user by tailoring it to the user's cultural context, while the global approach of uniting experts from different cultures and trying to find a common educational ground ensures that the project is efficient and financially sustainable.

Students' Perspectives on Local Content: A Preliminary Study Towards Evaluating the Usefulness of Malay Mobile Cultural Content

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ABSTRACT

Mobile learning is a new growth opportunity in developing countries like Malaysia where local content or cultural content which has traditional cultural elements are still novel. Because of the westernisation and globalisation of content and media, especially in mobile learning, local knowledge content is often neglected. It is alarming that one day local university students may not be able to appreciate, know and learn about their Malay cultural subjects. The research is mixed method qualitative and quantitative and of an exploratory nature, and the aim of this research is to investigate the area which has potential for Malay cultural content   due to its learning usefulness. A pilot survey has been conducted to discover areas which have the potential for creating appropriate local content for public university students and is discussed in this paper. Future research undertaken will include in-depth interviews, observations, focus groups and questionnaires involving Malay students from a public Malaysian Institution of Higher Learning.

Author Keywords

Local content, public university students, Malay, mobile phone

INTRODUCTION

This research is mixed method quantitative and qualitative and aims to understand what interest public students in Malaysia have in accessing useful cultural content for their learning. Three universities have been surveyed, namely the University of Education Sultan Idris (UPSI), University Putra Malaysia (UPM) and the University Technology MARA (UiTM). The majority of public university students in Malaysia are from Malay ethnic groups. This survey is divided into three sections: the students' background, students' experience using mobile devices, and Malay cultural content. The survey questions have been developed to require ticking Yes or No responses as well as open-ended questions for which students can write their answers.

The importance and need for local content has been suggested in the Universal Declaration on Cultural Diversity with a supporting Action Plan which was collectively adopted by UNESCO in November 2001 (Hampton, 2003; UNESCO, 2001). There has been growing concern about the lack of local content in the Malaysian media, for example, in television, radio, films, the internet and, in more recent years, mobile phones (Ariffin, Dyson & Hoskins-McKenzie, 2011). This is an issue for many minority cultures in the developing world where western culture is being empowered. From analysing the Multimedia Development Corporation Catalogue (MDEC Catalogue), it can be seen that there is a lack of variety in mobile local content and educational applications that have Malay cultural content for university students in Malaysia. In addition,

many of the local researches show that most mobile products are games, commercialised for profit and pure entertainment (Suki & Suki, 2007) and most mobile phone usage trends for students are heavily dependent on conventional SMS messages (Ismail, Idrus & Ziden, 2010; Sidek, 2010). By understanding the challenges and development opportunities, more local cultural content could potentially be identified and developed with knowledge and information to help students' learning through a more varied cultural content platform which might involve sound, animation, pictures and so on.

Minister Lim (2005) has stressed that content is the "king" and content is the key but unfortunately it has not happened yet within the Malaysian context. Similarly, the Information, Communication and Culture Minister, Datuk Seri Dr Rais Yatim has urged developers to produce local cultural content for mobile devices, as mentioned in a Malaysian newspaper The Star (2010). There is also a need for specific localised applications for mobile learning. Research into appropriate cultural content in the design of usable mobile learning applications for students at Malay public higher institutions is still novel despite the huge interest elsewhere in the world in using mobile technology to improve learning. Such applications could improve student understanding and learning outcomes in a subject which is related to art and design using mobile cultural content. Consequently, students' interest in learning could be enhanced via an information and multimedia format of software content or equivalent.

LITERATURE BACKGROUND

Bevan-Brown (2005) discovered that Maori students are more motivated when craft motifs are used for their learning; however, this research needs to be expanded to the novel mobile learning concept. According to Kukuska-Hulme (2010), mobile learning is still under-utilised in many areas of education. Also, it is already known that mobile learning is still a new phenomenon in Malaysia (Suki & Suki, 2007). Siraj & Alias (2005) analysed how mobile learning has successfully enhanced students' learning by enabling them to understand more complex tasks in Malaysian educational institutions. In addition, the mobile environment increases their confidence and cultivates an enjoyable context for learning. Their study shows that mobile learning is an effective teaching and learning method that will bring more benefits to students in educational institutions. Another example is that students at higher institutions could develop the content for mobile learning projects accessed via various mobile learning gadgets (Siraj & Nair, 2007). This study is clearly culturally inspired and based on cases and contrasts with other researches based on Hofstede's Cultural Theory and related to big organisations and inter countries studies (Ariffin, 2010; Lee et al., 2008). This research is therefore ethnographically inspired in context (Bødker, Kensing, & Simonsen,2004). The terms "local content" and "cultural content" interchange and are similar in this study. Likewise, the local content will use the mobile phone as the vehicle to disseminate the learning. The potential to integrate local cultural content via mobile learning makes it possible for students to use Malay content to assist their understanding of topics of study. One such prospective Malay cultural content resource is on Malaysian craft. Other possible topic areas for Malay Cultural Content are listed in Table 1 below.

Subject	Malay Culture Content
Crafts	local carving and weaving in art, clothes, e.g., 'Batik' and 'Songket'
Music	local folk music, folk song, children's lullabies
Stories	local folk stories, epic stories
Novels	local books and manuscripts, story, e.g., 'Hikayat'
History and Law	local history, law and politics, etc.
Science	local nature including plants, agriculture and food
Geography	local sites, places and information

Moral	local ethics, Islamic values, manners, e.g., 'Petua'
Exercise	local martial arts, e.g., 'Silat'
Medicine	local medicine and preparations
Language	local scriptures like 'Jawi' related to Arabic writing and Islamic religion and also poems 'Pantun', etc.
Customs	local rituals, celebrations, weddings, etc.
Performance	local dances and drama
Architecture	local houses and ship construction

Table 1. Malay cultural content

1.   A report from Unesco (2009) points out that craft can generate potential income for developing countries.According to the Department of Craft Malaysia (Malaysia Government & Malaysia Craft Dept,2010), Malaysian crafts are divided into five major categories. Of the content in Table 2 on Malaysian craft, batik is one of the most prominent crafts associated with the national identity of Malaysia through its national dress. Consequently, knowledge about local content could motivate interest for   Malay students, citizens and foreigners to obtain information about one of Malaysia's most popular crafts. Government bodies, agencies and departments would be the catalyst for urging local content creation. Hence, this generates a potential area for new research into Malay local cultural content that can be made available and accessible through mobile phones. This is also a potential source of knowledge to enrich students' learning, particularly in art-related subjects. For example, the art of craft and knowledge of motif and design has also been used in classes in the Faculty of Music and Performing Art in Malaysian public universities.

2.	3. Types of Craft	4. Craft Details
5.	6. Variety of Craft products	7. Craft art based on beads, paper, shell and pearl, etc.
8.	9. Craft from Textile products	10. Craft art based on batik, songket, embroidery, traditional knitting, threading, etc.
11	12. Craft from Metal products	13. Craft art based on metal, gold, silver, pewter, copper, etc.
14	15. Craft from Forest products	16. Craft art based on wood, bamboo, rattan, screw pine leaves
17	18. Craft from Soil products	19. Craft art based on clay crystal, glass and marble, etc.

Table 2. Malaysian craft

The current survey presented in this paper has been conducted to ascertain the opinion of students on Malay cultural content (like motifs and design). Usability of the local content is important to ensure the user needs in the context of Malay public university students are satisfied. This survey will provide the basis for future improvised usability inspections (ISO, 1998; Nielsen & Mack, 1994; Shneiderman & Plaisant, 2010) for local content and context for Malay public university students.

METHODOLOGY

The main approach of this preliminary research is exploratory with mixed methods. Quantitative data was derived and analysed using PASW version 17.0 statistics software package. The participants were selected by the convenience sampling approach (Mertens, 2011). One hundred and six university students from three different universities were surveyed. The majority of the students selected were Malay students from the public institutions of higher learning in Malaysia. The respondents were selected based on availability and different fields of study. These three universities were chosen because they are public government universities offering different fields of study. The survey questionnaire was adapted by expanding Bevan-Brown's (2005) idea for the Malaysian context, looking at design and motif. The pilot survey had 70 female participants and 36 male participants. The survey was been conducted with three universities: University Pendidikan (University of Education) Sultan Idris (UPSI), University Putera Malaysia (UPM), and University Technology of MARA (UiTM). The participants ranged from 18 to 30 years old.

This survey has been conducted to investigate :

Samples of questions:

    a.   Do students believe that Malay motifs and design increase understanding in learning art and craft?

    b.   Do students believe that Malay motifs and design increase motivation in learning?

    c.   Do students believe that Malay motifs and design increase self esteem?

    d.   What are the advantages of having cultural content with mobile phones for learning purposes?

    e.   What are the challenges of having cultural content using mobile phones for learning

       purposes?

    f.   Where do you like to use Malay culture for examples on motifs and design in your learning content?

FINDINGS

			Malay motifs and design could increase understanding in learning		
			No	**Yes**	**Total**
Uni	UPSI	Count	4	24	28
		% within Uni	14.3%	85.7%	100.0%
	UPM	Count	4	39	43
		% within Uni	9.3%	90.7%	100.0%
	UiTM	Count	1	34	35
		% within Uni	2.9%	97.1%	100.0%
Total		Count	9	97	106
		% within Uni	8.5%	91.5%	100.0%

Table 3: Malay motifs and design increase understanding in learning

From Table 3, it can be seen that University Technology MARA (UiTM) has the highest Yes response of 97.1 % compared to University Putra Malaysia (UPM) with 90.7% and University of Education Sultan Idris (UPSI) with 85.7%.

The total of Yes responses from the three universities is 91.5% for the proposition that Malay motifs and design increase understanding in learning.

Responses from the open-ended question are:

- "Enhance my knowledge on local content"

- "Will be easy to learn for local people"

- "I could use local content for my project and assignment and my subject"

- "Increase communication within the groups to disseminate knowledge"

			Malay motifs and design could increase motivation in learning		
			No	Yes	Total
Uni	UPSI	Count	6	22	28
		% within Uni	21.4%	78.6%	100.0%
	UPM	Count	10	33	43
		% within Uni	23.3%	76.7%	100.0%
	UiTM	Count	10	25	35
		% within Uni	28.6%	71.4%	100.0%
Total		Count	26	80	106
		% within Uni	24.5%	75.5%	100.0%

Table 4: Malay motifs and design increase motivation in learning

Table 4 shows that the University of Education Sultan Idris (UPSI) has the highest Yes response of 78.6% compared to University Putra Malaysia (UPM) with 76.7% and University Technology MARA (UiTM) with 71.4%. The total of Yes responses from all three universities is 75.5% for the proposition that Malay motifs and design can increase motivation in learning.

Responses from open-ended questions are:

- "It is fast and efficient way to get information. Everybody has mobile phone".

- "Preserving and sustain our Malay culture from being wiped out from other main global modern culture"

- "Students could appreciate and remember Malay cultural content in their life"

- "To know the uniqueness of our own local content"

- "Accessibility, practicability and mobility"

- "Reduce the usage of extraneous books"

			Malay motifs and design could increase self esteem		
			No	Yes	Total
Uni	UPSI	Count	4	24	28
		% within Uni	14.3%	85.7%	100.0%

		5	38	43
UPM	Count	5	38	43
	% within Uni	11.6%	88.4%	100.0%
UiTM	Count	6	29	35
	% within Uni	17.1%	82.9%	100.0%
Total	Count	15	91	106
	% within Uni	14.2%	85.8%	100.0%

Table 5: Malay motifs and design increase self esteem

In Table 5, University Putra Malaysia (UPM) has the highest Yes response rate with 88.4%, compared to University of Education Sultan Idris (UPSI) 85.7% and University Technology MARA with 82.9%.

Responses from open ended questions are:

- "Increase my patriotism spirit"

- "Increase my self esteem and identity to know about my own local culture"

- "Could promote our local culture to other ethnics while increasing our own local culture knowledge"

CHALLENGES TO USING CULTURAL CONTENT ON MOBILE PHONES

There are also challenges that need to be addressed in order for mobile cultural content to be useful for public university students. The lists of issues below are excerpts from the open-ended questions in the survey. To increase the chance of successful implementation of cultural content, the following challenges need to be resolved.

- Cost of application and telephone devices

- Less focus on work while more occupied with unproductive tasks like spending time chatting, movie watching and playing games

- Copyright issues

- Obtaining the appropriate local content for learning

DISCUSSIONS AND CONCLUSION

The responses from each university are positive and show that students believe that learning Malay motifs and design could increase their understanding in learning, motivate learning and increase self esteem. One of these universities will be used as the basis for future research. Meanwhile, challenges to using cultural content on mobile phones that need to be considered are: cost of the application and devices (Litchfield et al., 2009); time spend for learning purposes; copyright; and obtaining appropriate local content for the learning subjects (Litchfield et al., 2007).

Consequently, future research will involve questionnaires with the student evaluations for the usability of local content prototypes. Qualitative and quantitative mixed approaches like classroom observations, focus groups for students and in-depth interviews, and questionnaires with academics will be conducted. Further research will include an improvised survey on usability (ISO, 1998; Nielsen & Mack, 1994; Shneiderman & Plaisant, 2010) towards specific subjects (Litchfield et al., 2007), evaluating the needs and requirements of local cultural content (Ariffin, Dyson & Hoskins-McKenzie, 2011) with Malay public university students as the context.

These future activities will help to gain an understanding of the need for usable cultural content for local public university students and academics in relation to mobile learning. This will lead to the outcome of a usability framework inspired by local Malay culture content. The research outcome will serve as a framework for the design of useful Malay mobile cultural content for student learning.

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Mobile Research in the Wild: Practical Experiences with Mixed Methods

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ABSTRACT

Over the past few years we have designed and carried out a range of mixed methods studies of hand held technology, used by school children, across a range of settings including classrooms and field trips. In this paper we explore how these investigations have overcome issues and constraints faced when conducting such research 'in the wild'. An in-depth report of the key issues faced by researchers develops the literature relating to such studies by considering the constraints involved when multiple methods are being used, and, in particular starts to explore challenges faced when introducing quantitative and controlled experimental work into a more qualitative framework of data collection. Where possible we report techniques that we have used to overcome these constraints. We hope that these approaches will be useful to guide researchers' future mixed methods investigations of mobile learning in the school context.

Author Keywords

Experiment, Research, Constraints, Technology, Mixed Methods

BACKGROUND

The development of technology alongside a shift in ideas about how science should be taught to secondary age (11-18year old) students has led to a more holistically styled science curriculum. Students are now encouraged to develop an understanding of science as part of their everyday world whereas previously they were taught science facts by rote, with little reasoning and information about how the knowledge was discovered and what impact it has on everyday life. However there is now a change in focus, with students being taught more practical science, with a focus upon their discovering concepts for themselves. This is demonstrated in the "How Science Works" agenda (2007) released as part of the National Strategies from the UK Department for Education. In the description they report;

"How science works is more than just scientific enquiry. It provides a wonderful opportunity for pupils to develop as critical and creative thinkers and to become flexible problem-solvers."

"Effective enquiry work involves exploring questions and finding answers through the gathering and evaluation of evidence. Pupils need to understand how evidence comes from the collection and critical interpretation of both primary and secondary data and how evidence may be influenced by contexts such as culture, politics or ethics."

With reference to mobile and contextual learning this had led to increased interest and research in the use of hand held devices for discovering the world, collecting and gathering data. Much research [Pea (2002); Resnick et al (2000); Rogers et al (2004); Stanton et al (2003); (2005)] has shown that this approach to learning makes   data seem less abstract and supports the understanding of the scientific process alongside the understanding of the scientific concepts.

Our research has focused on investigating how the use of hand held technology can affect a learner's motivation and learning. As previous work has a clear qualitative emphasis, we chose to build upon this by using a mixed methods approach to further develop our understanding of the relationships between hands-on technology and learning. We have designed a number of mixed method investigations to quantifiably report upon the impact of our hand held interventions; for an overview see Martin, Stanton Fraser, Woodgate, Fraser & Crellin, (2011).

In this paper we discuss some of the constraints we have faced while conducting our mobile learning research. Our investigations have used data loggers as our mobile learning tools to explore the relationships between different forms of context and learning in hands-on, mobile learning settings. We first chose to conduct two purely observational studies to establish how a school currently uses hand held data loggers and gain further insight into how learners respond to this technology. The information gleaned from these studies was then used to develop our third study, this time a quantitative design, which was concerned with the role of data ownership and the impact of 'seams' on the transformation process of the collected data, from data logger to the traditional learning objects of graphs and worksheets. Seams are instances of disruption to the fluid data collection and interpretation process; see Chalmers et al (2008) for an overview.

Data loggers are interesting in this respect because they collect seemingly abstract raw data, but the software enables learners to combine this data with additional contextual media to provide the learners with a more in-depth picture of a situation. Using the software, learners can carry out operations such as data collection, data selection and data annotation all within the same program, allowing a continuous progression from mobile learning outside of the classroom to the more traditional analysis within the classroom. Work by Woodgate et al (2010) suggests that, while data loggers are developed to support a seamless procedure, disruption to this process can aid learning in other ways by providing opportunities for learners to discuss and reflect upon their experiences of the scientific process. Thus our study was interested in whether learners who had a seamless experience performed differently than those whose experience was more 'seamful'; in other words, would those who had to work to acquire or analyse data show a different learning and motivation response to those who had a more automated experience?

Forty-six school students took part in the third study, which compared multiple levels of data collection. Half of the students were exposed to mobile learning devices and instructed to collect their data 'self collected', the others were merely given a talk about data logging. When the 'self' learners returned they were asked to discuss their data with a partner. This provided the partner with the data 'peer collected'. Each student was then asked to analyse their data or their partner's data. The pairs got to analyse and produce graphs from the data either by   using data logging software 'Software Presented', making posters from graphs of the data pre-produced by the researcher 'Pre-generated' or by using the numerical data to produce hand drawn graphs 'Manual'. Quantitative analysis of pre and post tests revealed that hands-on learning effects were limited. However while self-collection did not seem to affect understanding, it did positively affect motivation.   For more detail see Martin et al (2010).

The results of this study introduced further questions about the role of technology in hands-on learning, with a key question about the inherent novelty effects.   We explored this further in a fourth study, by comparing a mobile hands-on learning activity with and without technological devices. Twenty-one students were given an open task of developing an understanding of the relationship between pulse rate and exercise. Half of the learners had a 'traditional' experience of

calculating their pulse rate using the fingers on the wrist technique, while the other half was shown how to use data loggers with a pulse rate attachment that clipped onto their finger. Each learner completed pre and post questionnaires. The results of this experiment were surprising, as we found that the data loggers confused the learners as they challenged their current perceptions. Nonetheless, any form of hands on experience had a positive effect on both learning and motivation with learners becoming more confident in their answers.

Our final study, which is ongoing, follows a Year 8 (age 12-13) class to provide a real-life understanding of the impact that mobile learning using data loggers and the provision of associated contextual data can have on learners' science learning and motivation over a longer period of time. Students are taught six science modules; two modules involve data loggers for every lesson, two modules encourage the students to document their learning using cameras and two modules are taught more traditionally to allow for comparison.

During our investigations we have had to adapt and change our methodologies to overcome certain characteristics and issues of our investigating environment. By choosing to use a mixed method approach we have had to work hard to ensure that our research was as controlled as possible, but avoided distorting the normal learning environment too much. As researchers we are aware that we cannot stand outside of our work and just observe; we note that by choosing to conduct research we are inherently changing what we wish to observe. Work by Danziger (1990) emphasises that we need to recognise the social nature of scientific activity, ensuring that, when attributing cause and effect, the researcher must be aware of their own involvement in shaping the environment within which the experiment occurred. As researchers in the wild it is vitally important that we consider how our own presence may have an impact upon our results as well as our designed interventions.   Previous work by Woodgate and Stanton Fraser (2006) reports on some of the practical issues of working in schools. They list 7 key constraints and issues which they have faced in their research;

1) *National Curriculum: Research initiatives will more likely be taken up by teachers if they can be used to teach the curriculum as it means the teachers do not need to find extra time to cover the entire syllabus.*

2) *Time: Activities designed need to be easy to run and require little additional preparation work from the teacher.*

3) *Technology: It is important to discuss new technology with teachers and support staff, if new software is required then it is important to give advance notice. It is also important to bring spare equipment in case of fault.*

4) *Usability: It is important that the research is valid and that the technology must be usable and of benefit to the students, and not just shiny and novel.*

5) *Timetable: Consider your research, is it possible to conduct your work within a lesson or would it be more appropriate to work with an after school club?*

6) *School Terms: Be aware that schools have many events which cannot be moved, such as OFSTED inspections, exams and holidays. It is important that the researcher is flexible, sensitive to the needs of the school, and works with the staff to time the investigation appropriately.*

7) *Consent: Full consent will be needed from the parents, as well as from the school before research can take place. In some cases schools may ask the researchers to obtain Criminal Records Bureau clearance, if this is the case it is important that this is done well in advance of the research.*

It is important to be aware of these seven issues when planning research. During our more recent mixed method research however, we have found additional constraints with regard to introducing mixed methodologies into classroom research. We believe future researchers would benefit from knowing of our experiences. By producing this report, we hope to inform other researchers and allow them to develop more effective mixed methodologies for research in schools. We have grouped the issues into two key sections; those to do with collecting data, and those concerned with working in a classroom, see figure 1.
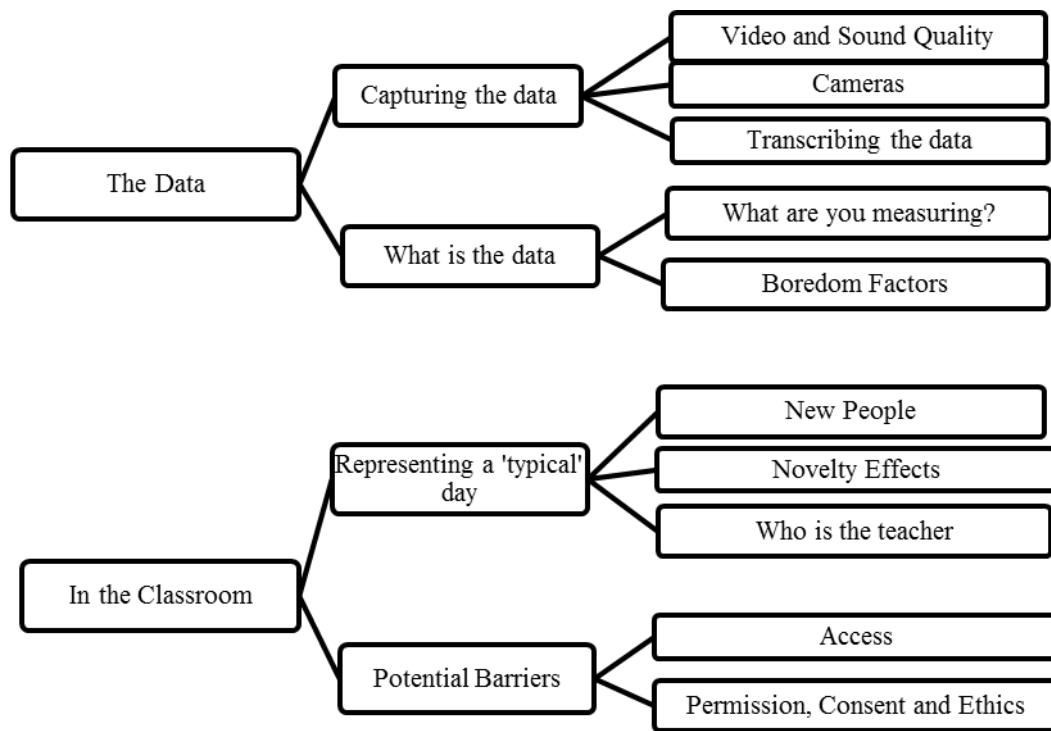
Figure 1. Issues which researchers may face.

THE DATA

Capturing the Data

Video and Sound Quality

Classrooms are inherently noisy locations. Even when the students are working quietly, there is a constant murmur of conversation, bags rustling and chairs moving. This can make it very hard to capture meaningful data using a basic video camera. This can be especially hard if the camera is placed away from the students to encourage a normal lesson. It can also be hard to capture the 'interesting' bits of a classroom with a video camera as you need to constantly zoom in and out. One solution to this is to have multiple cameras or researchers, providing more scope and data. However by introducing more researchers you are further changing the original environment.   It is also costly in terms of resources and researcher time. In addition to this when you are collecting both quantitative and qualitative data it is important that you have thought about the different types of data you will be collecting and how you will analyse it. . While it can be useful to have video to reflect upon, if the focus of the research is to produce quantitative results then collecting a large amount of video data can be overwhelming, and hinder the researcher's ability to focus on the appropriate data.

If you are interested in capturing computer screen information, to see how students learn and respond to tasks, it is advisable to install a screen capture program as it is hard to video tape computer screens; Figure 2 shows the difficulty in video recording what a student is doing on the computer.

Cameras

It can be hard to capture video data as students often vary between two extremes; camera love, and camera hate. Students who hate the camera tend to become silent when the camera is near them, reducing the likelihood of the researcher capturing useful data. There is also the possibility that they will refuse to take part. Students who love the camera can be just as frustrating for the researcher as they tend to be distracted by the filming process, acting up for it, or constantly vying for its attention. Rarely are these students on task, as they are too preoccupied by the camera. If the students are merely interacting with the video camera then useful data are unlikely to be obtained.
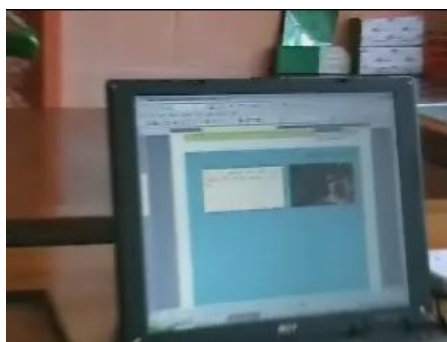
Figure 2-Example of attempting to record a student's computer screen

Examples of these two extremes can be seen in Figures 3 and 4; in Figure 3, the student is playing around in front of the camera, rather than working on the laptop. In Figure 4, the students at the table had requested that their faces not be in range of the camera, resulting in the capture of only audio data.

Figure 3- Example of as student interacting with the camera rather than working on the laptop.

Figure 4-This student did not want the camera pointing at their face so the camera was repositioned to collect only audio data.

To reduce the effect this has on the results it can be useful to have a camera running for longer than the duration of the experiment, as the novelty may wear off and the students forget about its presence. It is also easier if the research is longitudinal in nature, as this allows the students to become accustomed to the presence of the camera and the researchers. If the camera is having an inhibiting effect upon your research, it may be worth considering removing it and relying on other forms of data.

Transcribing the Data

Attempting to transcribe audio and video data obtained from a classroom environment or while on a school trip can be very hard. Students tend to talk constantly and this can make it hard to pick out specific phrases. When outside of the classroom other external factors may also have an impact, for instance the noise of traffic or the wind may overpower the students' voices. Aside from employing a well trained camera operator there is little to be done about this. Researchers should be aware of the limitations and spend their time in the field appropriately, listening out for interesting comments and responses.

It can also be very hard to decipher a student's handwriting; in our later studies we developed our methods to include computers for the students' use, making it easier to decipher their responses. It can be useful to discuss your written data *with the teacher as they will likely have more experience at understanding what the child has written. Figures 5 and 6 show* how it is easier to read the typed response than the handwritten annotations.
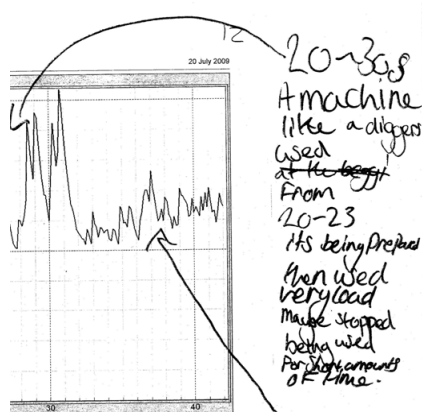
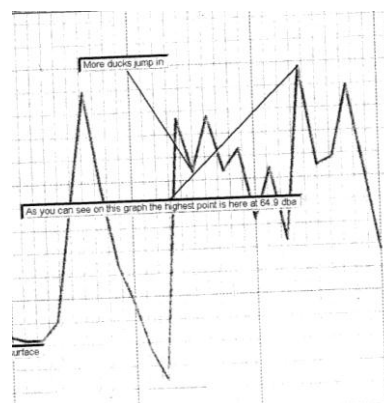**Figure 5-Example of student handwriting which is hard to decipher.**

Figure 6-Example of a student's typed response; this is easier to interpret than a hand written response

What is the Data?
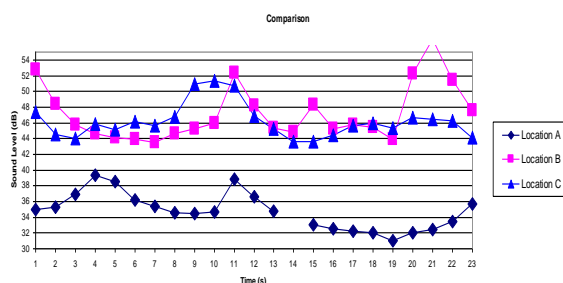
What are you measuring?

When measuring learning it can be hard to know if you are indeed measuring value added learning or something else. This is a known issue, as anyone who has ever done badly in an exam may claim that the exam did not ask them the right question and that it was not fair. It is important that measures of learning offer an opportunity for a student to show their knowledge in multiple ways. Often tests fail to provide an adequate platform for the student to display their learning. For instance during one of our experiments we aimed to determine the learners' understanding of graphs; the learners were shown the following graph (see Figure 7) which was derived from curriculum resources. We then asked the learners to comment on what to do about the missing value;

According to the National Curriculum marking scheme, the answer to this is C '*the data should not be replaced'*, however, a number of the students chose answer B and gave interesting justifications such as;

"It should be in the same area as the rest of the marks as the sound wouldn't of increased by a huge number in that small space of time"

"Well it could be anything making it impossible to mark upwards or downwards but you know it must be in line with 14s"

Clearly these students have grasped important understandings about the graphs and data; however the structure of the question does not allow them to justify their response. If the learners were graded purely on their response to A, B or C then students who reported B would have been marked incorrect. It was only by providing an opportunity for the students to explain their reasoning that we can gauge their understanding. It is important that when designing tests that they are piloted with learners who are given the opportunity to discuss their responses.

Figure 7-Sample question which limits learner's ability to show knowledge

A second issue can be in determining whether the 'learned' material has been retained in the long term or merely temporarily. One method researchers use to understand the depth of learning is to use delayed post tests after a period of time to assess whether the student has retained the knowledge. The key flaw in this is that during this time, the student will

have had new experiences which will undoubtedly affect both their learnt knowledge and their ability to apply it. A key question is 'to what extent does this matter?' If we are researching in the wild, and wish to understand the impact of our interventions upon a student in the real world, we must acknowledge that we cannot control what happens to the student in-between testing. It is therefore impossible to satisfactorily say that our intervention has been entirely responsible for a particular effect. As a consequence, it is not possible to completely quantify learning. This is in part due to learning's complex and hard to measure characteristics

Boredom Factors

It is important that researchers consider how they are going to assess the effects of their intervention on the learners, and the methodologies which they will employ during their investigation. Our experiences suggest that school aged learners will become bored easily and it is necessary to switch activities frequently to avoid this. We have therefore adapted our methodologies to include a range of activities for assessing student learning. For instance, we have employed online questionnaires so that students do not have to write out their responses in longhand. We also build in activities which are designed to be interesting for the students even though they appear to have less direct research benefit. By working with teachers to design our studies we are able to ensure that the activities that we provide are both stimulating and informative. It is important that researchers are aware of the limitations of their data collection methodologies; for example, providing students with online questionnaires and likert scale based questions restricts the responses the students can give. While this makes it quicker for them to complete, it can limit the potential range of responses.

IN THE CLASSROOM

Representing a 'typical day'

New People

As with any social context, by entering a classroom, you are changing it. It is apparent when you do research with a group of students that you are impacting on their normal school routine just by being there. While it is possible to argue that students are constantly encountering new people, such as student teachers or OFSTED inspectors in their classroom, it is important to consider what effect your presence in the classroom may have on the classroom dynamics. This again supports the idea that it may provide more valid results if the researcher is in the classroom for a longitudinal study, as this will allow the students and the teacher to become acclimatised to the researcher and act more naturally. It is important for mixed methods studies that the research is controlled as much as possible; as a result it is important that students in different conditions experience the same kind of interaction from the researchers. It would not be appropriate for class A to experience a 'Hands-on' researcher while class B has a researcher who only observes if you are intending to uses the classes for comparison of an intervention. Research teams need to discuss in advance how they will interact within the class; will they be a member of the class or an observer, and how much detail can they give the students about the research?

Novelty effects

A similar issue can be the novelty effect of not only the tools which may be being investigated, but also the research itself. Students tend to act differently at the start of the experiment compared to the end. Thus it is important that the experiment is long enough that your data collected can represent more than the initial novelty effect of having someone new in the classroom, and taking part in new activities. It is also important that when you are investigating the effect of a tool on the students that the intervention is long enough for the students to cease to respond to the novelty effect of the technology.

Who is the teacher?

A key frustration for researchers is getting the balance right between the researcher and teacher. Very often the researchers will know more about the technology that they are introducing than the teacher, so the teacher may rely on the researcher more than is ideal to provide support; this changes the researcher's role from research observer to active participant in the classroom. This can be hard, as not only does it take them away from the job they need do; observing, but it can also be intimidating if they need to take on a teaching role. Without proper training, this can be daunting, as the researcher will

need to be able to take control of the classroom and maintain order. To minimise this, it is important to discuss the technology with the teacher before introducing it to the class. It is also important to work together to plan lessons.

Potential Barriers

Access

A key issue with researching within a school results from the limitations of the school timetable. Research can be restricted by curriculum, exams, term dates and many other factors. Some schools may need you to show evidence of benefit to their students to take them off timetable, or if you are working within a typical lesson you need to be aware of how long a lesson is and how much actual teaching can happen during that time. For instance teachers may need to discuss homework, exams, coursework, discipline; all of these will take time away from the topic. In addition, if you wish to provide an intervention into the typical lesson and manipulate how or what the students learn, you will need to do this in conjunction with the teacher and work together to ensure that they can still deliver the curriculum, and that the students will not be adversely affected by this change.

Location

When conducting research it is important to consider where you will be conducting the investigation. In many ways it can be beneficial for an experimental investigation if you can have the students visit an area which the researcher has control over, such as their lab. However, while this mimics a student's field trip, it would not be representative of everyday learning in the classroom and would potentially be affected by the novelty effect of being out of school. Despite this, using the lab has clear benefits when trying to control an experiment, as the researcher can provide everything required and control aspects as required. It is also more likely that the investigation can last longer than a standard lesson. When designing your investigation it is important to consider your options about whether it is preferable to research inside or outside of the school context.

Permission, Consent and Ethics

Another key problem with researching with schoolchildren is gaining permission to do so. It is important to gain ethics approval and full consent for the research. It can be hard to get full consent for research within a classroom as you need to ask the teachers, parents and students. If a parent/ student declines then methods must be used to overcome this obstacle as it would be inappropriate to expect that a student would be removed from the class because a researcher is present. A useful method for gaining consent is to work with the teacher to design the investigations to be part of the standard lessons, and then ask two consent questions; one for involvement in the investigation, and a second question about videoing data, if this is required. This allows for the student to continue to take part, but not be included in the video analysis of the investigation. Very often a teacher will be willing to change a seating plan so that non-consenting students can sit outside of the video frame. This situation arose during one of our investigations. In this case, only half the class gave consent to be videotaped, although all gave consent to take part and provide all other forms of data. To overcome this issue, we redesigned our experiment to run with four groups rather than two. This meant that two of the groups could be videotaped, and two could not. It is important when conducting research to be able to think quickly and rearrange the experiment if necessary.

We have found it is important to be very organised and flexible in designing our studies. For example, we have used methods of colour coding, and asking students to have 'team' names so that it is obvious who was in which group at a later date. It is important that, if you choose to use some form of labelling of the students, for instance colour coded stickers, that you make an effort to use the students' names during your time with them, so that they feel that their individual contributions are valued. Colour coding student response papers and the students in the video, through the use of stickers, can be useful when reviewing both quantitative and qualitative data back in the lab, as it enables the researchers to have a visual reminder of how each student interacted, which can support and inform the quantitative responses. .

CONCLUSION

In this report we have built upon the work by Woodgate & Stanton Fraser, (2006) to provide an overview of some of the limitations of conducting research in the wild using a mixed methods approach. We have discussed the issues of trying to

effectively videotape student learning when in a normal environment and how this in itself can have an impact upon the student behaviour. We have also considered the constraints of working within a school environment compared to working in a research lab. We have raised issues which we have faced during our own research, and, where appropriate, explained our methods for overcoming them, and the rationale behind our adaptations. In summary we suggest that researchers work in close collaboration with schools and teachers to overcome basic issues such as lesson planning, timetabling and gaining permission. It is important that researchers are aware of the constraints of conducting research in the wild and are willing to adapt their research to factor this in. We would advise that, where possible, studies are longitudinal to reduce novelty effects and that measures and assessments are piloted and appropriately designed to allow the students to show what they have learned, as often they will have learned more, and differently, than is first thought.

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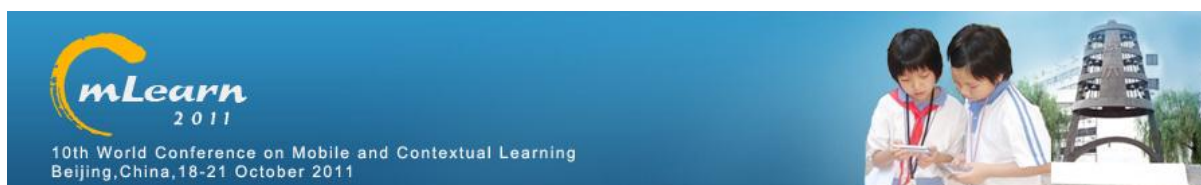
mInteract™: Student Mobiles For Online Experiential Interaction In Any Learning Space.

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SYNOPSIS

mInteract™ is an online tool developed to support interactivity in all learning spaces at sites of formal and informal education. Cheaper, more versatile and easier-to- use than commercial clickers, mInteract is a no-to-low cost web-based application that allows students to use their internet-enabled phone, tablet, laptop or other networked mobile device to improve learner engagement. The ownership of 'smart' networked mobile devices is rapidly increasing so the tool has the potential to improve experiential learning everywhere mobile technology works.

The tool already supports multiple-choice questions, text or number answers, short answer questions, peer evaluations, and single or multiple selections of answers from a list. These activities are used alone or can be combined into short quizzes. Teachers introduce mInteract activities at a relevant time and students use their mobile to respond anonymously. The responses are instantly collated by the software and the teacher can then choose to display and talk to the outcomes. The teacher normally presents the responses back to the students via big-screen display of results - bar graphs, lists, movable text answers, etc. This quick feedback allows students to immediately evaluate their understandings and the teacher can respond and adapt improving engagement and experiential learning resulting in learning gains.

Students are most reluctant to expose weaknesses, volunteer answers or raise their hands in lectures. Issues of language proficiency and cultural attitudes are difficult to address. However interaction via mobile devices is anonymous, removes inhibitions and increases engagement and thus learning. The rapidly increasing ownership of networked mobile devices makes mInteract most viable. All evaluation has been very positive and those students who did not use mInteract still were actively engaged as at home when watching a TV quiz show mentally answering and checking whether their answer was right. Highest student feedback were for these mInteract features; checking my understanding, quick feedback, getting the teacher's response, finding out what others think, and using the tool was anonymous..

Due to mInteract's instant collation and display of responses feedback is quick and thus most useful in correcting misconceptions. Student's meta-cognitive skills of knowing how to learn and taking responsibility for their learning are directly enhanced developing independent thinking capacity. As one student noted mInteract is "practical, fast and cheap and helps the student to see if they understand the topic and know how to apply concepts".

Since 2008 mInteract has been trialed, evaluated and improved in a first year subject 'Accounting for Business' with large student numbers at the University of Technology Sydney. It is intended to make mInteract available as open-source

software to encourage widespread use, support further development and to facilitate and enhance sustainable, interactive, experiential learning everywhere.

MINTERACT PROVIDES GREATER ACCESS TO PROVEN QUALITY LEARNING APPROACHES

There is a considerable and very positive body-of-knowledge about Audience Response Systems (ARS) directly relevant and supportive of mInteract. Research has consistently shown that in lectures the concentration span of students is no more than 15-20 minutes and then an activity is needed for students to refresh their cognitive capacity to process further information. Using mInteract is aligned with learning theory and pedagogical approaches such as student-centred interaction, timely feedback and teacher adaption, improving student meta-cognition and self-directed learning, and the prompt application of just learnt concepts to build understandings.

These approaches can best be articulated as experiential learning (Kolb 1985) where cycles of action, feedback, reflection, adaption and abstraction mean students learn by doing and reflecting. Using mInteract enables significant teacher advantage as they become aware of the real status of student understanding of concepts thus providing the opportunity for further explanation if difficulties are identified. Both student and teacher experience cycles of learning which illustrates the concept of an experiential transaction (Itin 1999) between student and teacher.

MINTERACT IS AFFORDABLE AND SUSTAINABLE

mInteract's use is sustainable as students use their own devices and institutions do not need to purchase expensive ARS hardware, software and renewal licenses together with maintenance and security costs. SMS-based systems are comparatively expensive for many students at for example 25c a message. When students use mInteract there is no cost if WiFi is available or at no-to-low cost using telecoms and mobile data plans. When using pre-paid mobiles trials have shown that due to mInteract's use of packet technology, costs are 1 cent for a single activity and at most 4 cents for a short quiz. Thus using mInteract say 4 times a week over a semester will cost students no more than $1 which is cheap and sustainable. The tool's no-to-low cost makes adoption more attractive and its pedagogic advantages more available.

MINTERACT ENABLES SERVING SIGNIFICANTLY MORE LEARNERS

mInteract is far more sustainable than commercial ARS's as the tool uses students' devices and packet technology to minimize costs. Institutions can encourage the use of the application to improve interactivity in all lectures without needing to purchase ARS hardware, deal with resultant security issues or pay ongoing license fees. Those students without a networked mobile are still engaged as with a TV quiz show.

MINTERACT IMPROVES THE QUALITY OF LEARNING OUTCOMES

mInteract's strength is in providing immediate formative feedback to all students and the teacher about the levels of understanding in the cohort. Students can check their understandings and the teacher can adapt their presentation to cater for misconceptions. This affordance improves the clarity and quality of learning outcomes.

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FURTHER DETAILS ABOUT *MINTERACT*;

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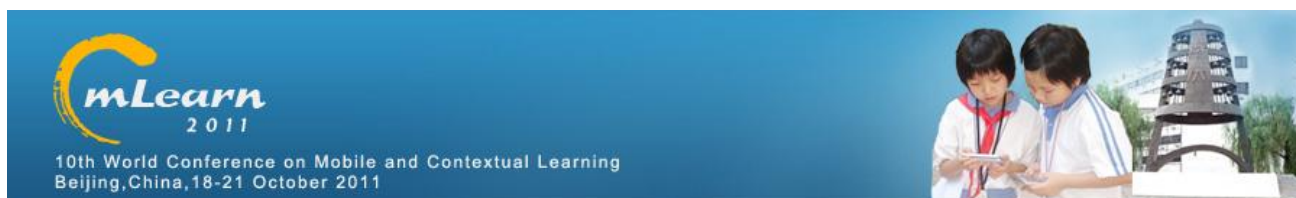
Using mobile for English language learning and teaching

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ABSTRACT

The British Council has been active in mobile learning since 2006 using it as a delivery mechanism for English language learning and teaching. It is seen as an important step in achieving the British Council's ambition of providing every learner and teacher of English access to quality language services from the UK. Mobile learning interventions include the development of smartphone apps, using SMS to deliver text based language learning materials, deploying iPads in the British Council's language centres and using mobile for developmental projects.

INTRODUCTION

The British Council has been active in mobile learning for a number of years starting with the development of basic language games for Java phones in 2006 and trialing the use of tablets in language classroom in 2007. Content was first delivered via SMS to learners in Colombia and Thailand in 2008 and via smartphone applications in 2009.

The British Council is today utilising various mobile technologies to deliver language learning in radically different contexts. This is being done in:

- face to face teaching offered by the British Council's network of teaching centres,
- through delivery of content via global app markets such as Apple's iTunes and Android Market and via SMS through partnerships with mobile network operators and
- through partnerships with organisations such as Nokia and Intel to remotely deliver content linked to local curriculums.

By adapting language learning content for delivery via these different channels we aim to provide learners and teachers of English with quality language services regardless of location or the type of mobile device they have access to.

Teaching centres

Teachers at the British Council have been using mobile devices in their classes. A recent case study showed how one teacher used mobile devices in his English lessons at the British Council in Hong Kong. This teacher has been using mobile phones in his English classes with secondary school children. In these classes, all pupils own a mobile phone although not necessarily a smartphone. He has found that getting the students to engage with their phones has been a motivating and personalising experience for the students. One example of class use has been taking advantage of the affordance of the camera and storage that most phones are capable of. By using the photos students store on their phones as springboards to discussions the students have been more motivated to talk in class and the personal experience has been more enriching for the students.

Case studies of students in the British Council Hong Kong have investigated the learner experience of using smartphones in English language learning. Analysis of the data showed that English was being acquired through the use of apps in general

and social networking in particular. The opportunity to have some language specific apps in a device that is always carried around was not lost on the participants with participants using referential apps such as bilingual dictionaries, translation apps and data collection tools in class and listening tools out of class.

More research is being undertaken focusing on the use of class sets of iPads in English language classrooms in the British Council teaching centre operations in Korea and Singapore. The first interaction with the iPad begins at a proficiency test. In the past testers had found that the nervousness of being in a test situation (albeit an informal one) made the prospective users uncomfortable. The use of the devices reduced these affective barriers by providing a distraction from the situations – prospective students were asked to comment on the images on a presentation on the device and interact with the device to choose topics to talk about. The devices are also being used as an integrated part of classroom lessons and are replacing other technologies that were being used but were found to be more intrusive – such as lap tops and multimedia rooms.

Content delivery through apps and SMS

The British Council has developed a suite of mobile applications across smartphone platforms. These apps focus on the skills and systems of the English language and provide learners with practical educational support for English learning that is not bound by the classroom. These apps were used in some of the case studies mentioned above. More information on these apps can be found at http://learnenglish.britishcouncil.org/en/mobile-learning.

SMS has also been used to deliver content via subscription services which deliver phrase-of-the-day content as well as interactive quizzes where learners can respond to questions via text messaging.

With partners

The British Council is engaged in a number of activities to provide English language materials and learning opportunities remotely. This is often done in partnerships with other organisations who provide the mobile technology infrastructure. For example, a project starting in summer 2011 has seen the delivery of teacher training via Blackberry Messenger services in remote areas of Indonesia.

British Council is also currently partnering with Intel to provide content for primary and secondary learners of English in Vietnam. This content will be pre-loaded onto subsidised laptops which will be released onto the market this summer. It is hoped that by 2020, every household in Vietnam will have access to a laptop with pre-loaded British Council content. The "English Learning Software for Everyone" project was unveiled in Vietnam with the news that 100,000 computers have already been sold – all preloaded with British Council software.

The content is designed based on materials from two of British Council's most well-known English learning websites LearnEnglish Central (http://learnenglish.britishcouncil.org/en/) and LearnEnglish Kids (http://learnenglishkids.britishcouncil.org/en/). Both have been localised by mapping them against local curriculums and ensuring them have a Vietnamese interface. Further discussions are already underway between Intel and the British Council in Thailand and Indonesia to roll this initiative out wider.

Also in Vietnam the British Council is aiming to reach thousands of teachers who lack ready access to relevant resources to support their teaching: resources such as lesson plans which relate to their curricula, lesson ideas appropriate to their contexts, methodological articles that are anchored in their particular teaching contexts and distance support systems which enable them to access learning opportunities directly.

Using the Nokia Education Delivery platform the British Council will deliver authoritative, bespoke English language teaching content to 200 schools that would otherwise not have access to support. As well as providing quality teaching and learning materials mapped to the national curricula, the parties have agreed to provide professional development to prepare teachers for effective integration of the teaching and learning processes.

The British Council will continue to develop mobile learning experiences for English language learners and teachers and evaluate the interventions described above.

Using netbooks and Web 2.0 technologies to facilitate mobile learning

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ABSTRACT

The purpose of this paper is to introduce ways that netbooks and Web 2.0 technologies can be used to support mobile learning. After defining our understanding of mobile learning, we will proceed to show how netbooks can be put into immediate use in the teaching practice. We will share two case studies for using a popular Web 2.0 tool (Blogging) for enhancing student learning and for teachers' reflection on educational project development. It is suggested (Bryant, 2006) that mobile technologies can support social constructivist theories of learning by expanding discussion beyond the classroom and providing new ways for students to collaborate and communicate in their own classes and around the world. Our challenge is to identify practical approaches that support the process of gaining new knowledge, skills and experience within mobile learning environment, assisted by the technology.

AUTHOR KEYWORDS

Web 2.0, Blogging, netbooks, mobile learning, social constructivism, project development.

DEFINING MOBILE LEARNING

Some authors associate the term mobile with mobile phone. Other authors define mobile learning as learning connected to a mobile device. Other advocates define mobile learning "in terms of the mobility of learners and the mobility of learning, and in terms of the learners' experience of learning with mobile devices" (Traxler, 2007).

Mobility is about increasing a learner's capability to physically move their own learning environment as they move (Barbosa and Geyer, 2005). Viewing mobility as an essential part of the interactions between people and technologies places mobile learning in a different prospective. Our understanding of mobile learning is based on social constructivist approaches to learning. Constructivism creates a learning environment that emphasises collaboration and exchange of ideas. Constructivism gives students ownership of their learning, since they are engaged through questions, explorations, and designing assessments. Web 2.0 offers educators a set of tools to support collaborative forms of learning that can encourage publications, multiple literacy and inquiry. A learner-centred approach is the main focus in our school ICT strategy for using netbooks and Web 2.0 technologies. We have adopted the slogan "IT's not about the technology, it is about the learning".

BACKGROUND INFORMATION

Since September 2010 the school has provided netbooks for all students and staff with Internet connectivity via wireless network.

The introduction of the netbooks has given ICS a powerful tool for learning. Students value the fact that everyone has a Netbook, which they do not need to share. The autonomy that this hands to young learners has had a significant impact on the students' learning in a short period of time.

The students have taken the initiative to access the wireless Internet for research, to use email for communications with their peers and teachers, to explore websites for revision and knowledge development, to produce presentations and slideshows, to share ideas and projects online and reflect on them remotely and at anytime.

Web 2.0 tools and the wireless netbooks have been used for creating engaging student-centred learning environments and for enhancing students' creative activities: taking and editing photos, producing sound and video clips, animations, creating online multimedia posters to present project ideas or homework, writing digital multimedia stories and creating websites. Students clearly feel that they are able to produce independent work that is a reflection of their ideas and imagination.

Flexibility and connectivity have also been great catalysts to the success of collaborative activities. The students have been more enthusiastic about team work than in previous learning environments as they found out-of-class sharing information and communication greatly assisted by Web 2.0 technologies.

The initial students' feedback collected via web-surveys is very encouraging.

(We asked: "Tell us what interesting things you have done with your Netbook?")

"Designing and creating something such as a timetable or a product (e.g., video storyboards, multimedia presentations using free online tools)." ; "Cool animations for projects and doing really interesting essays." ; "Making presentations; a brochure of something; and design a T-shirt in technology."; "I have researched, contacted my friends and teachers when needed."; "I listen to music and I go onto my Maths work."; "Go on Youtube, e-mailing, school work."; "Skype, watch Youtube, research topics of study, email messages and speak to friends on Facebook."

CASE STUDY 1: "USING WEB 2.0 TOOLS (BLOGGING AND GLOGSTER) FOR ENHANCING TEACHING AND LEARNING IN ENGLISH"

Blogging has the potential for enhancing teaching and learning – Blogs are not only great tools for personal reflection and sharing opinions but they can also be used effectively in the delivery of formal curricula and can boost student communication skills.

In ICS, we are seeing good initial practice emerging where teachers are guiding students on how they can effectively utilise Blogging for their learning. We are expecting the following impact on learning:

- the information in a Blog is accessible 24/7 and could be used for revision and reflection and as evidence for learning and assessment;

- students can use Blogs to develop their e-portfolios;

- reading the Blogs will allow the teacher to get feedback of what the students have understood or misunderstood. This will allow the teacher to structure the lessons to assist more personalised learning;

- students can also learn from their peers and take control over their own learning;

- quiet or shy students and those who have English as a second language can blog at their own pace;

- Blogging could be used as a catalyst for sharing opinions by all students and could encourage students to explore their comments in face-to-face discussions;

- finally, we expect students to enjoy and have fun whilst Blogging which can enhance their overall performance and achievements.

The pilot Blogging case studies have been very encouraging. Initially, teachers created Blogs for publishing students' work and comments. The published examples of students' work and students' comments have been used for reflection and provided evidence for student learning.

For example, a student group has been using netbooks to work on online multimedia posters for English lessons.

Students have been studying the novella ("The Pearl" by John Steinbeck). The question for this unit is: "How can a sudden change in status affect the way people treat us?"

In addition to class discussions, answering questions based on the book and other materials, students have been working on creating a Glogster (online multimedia poster) for this unit. In their Glogsters students included, text, images and sound. All students, even those who were not extremely confident in using technology, were engaged and eager to work on it. Evidence of students work in progress was published at the Glogster Blog together with students' reflective comments: http://glogsterproject2.blogspot.com/2011/06/students-share-their-views-about.html

STUDENTS SHARE THEIR VIEWS ABOUT GLOGSTER PROJECTS

Teacher's question: Can you please share with me what you think about this project?

Student's comments: "I think it's a good project because we can share what we understood about the book and how we understood it, we can say what happened in the book and share it with different people everywhere."

We have started to appreciate the benefits of Blogging for keeping records of student work progress, for sharing ideas and for reflection - all accessible remotely, 24/7.

We have seen clearly that netbooks and Web 2.0 technologies have the capacity to support a range of individual and collaborative learning tasks that may benefit students. Web 2.0 tools encourage participation, and they are intrinsically social and open. These principals comply with modern education theories such as constructivism and connectionism and thus make Web 2.0 very attractive for education. As young people feel in greater control of their own learning we expect continuous improved performance and outcomes.

CASE STUDY 2: "USING BLOGS FOR EDUCATIONAL PROJECT DEVELOPMENT"

Recently, we have been considering of whether or not it is useful to create project-specific Blogs to assist teachers in developing school wide initiatives. The immediate positive is practical: a well structured project approach, resources and on-going comments during the development stage available 24/7 and remotely would help tutors to effectively manage the process.

We have created a teachers' Blog for the recent school wide "E-safety" project. The teachers were able to share resources and comments. The Blog has also been used as a professional development tool for teachers. The teachers have shared good practice and considered advice from internal and external advisers.

Teachers preferred addressing project issues on an ongoing basis through comments on the Blog rather than reviewing negative aspects after finishing the project when it would be too late to make improvements. The project blogging has been used for reflection on the process of project development, for promotion of student achievements and publishing of the winning project products.

Below is the link to the project development Blog:

  http://ict4teachers.blogspot.com/2011/05/welcome-to-my-blog.html

Using wireless netbooks and a mobile learning environment have allowed teachers to be flexible in terms of both the time and the location of their work. This plasticity assisted frequent submissions and enhanced the teachers' understanding of project development.

CONCLUSION

By introducing two case studies of using Blogging assisted by wireless netbooks, we hope to draw the attention of other practitioners to the potential that these technologies have to support mobile learning in line with social constructivism approaches. Web 2.0 tools and mobile learning create the opportunity for students and teachers to develop personal identity and cultivate relationships with their peers across the Globe by posting and exchanging digital materials, joining project groups, sharing information and building up knowledge at anytime and remotely. We have provided web-links to the created blogs which could be used as practical examples for developing similar pedagogical approaches.

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