Mobile-Enabled Language Learning Eco-System

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ABSTRACT
This paper provides an overview of a Design-Based Research (DBR) study which resulted in a prototype of the Mobile-Enabled Language Learning Eco-System (MELLES) and replicable design principles to guide development of practical innovative mobile learning interventions. The MELLES solution was generated to augment in-class practice of ESP skills with learning embedded in real-life dynamic communicative situations. The solution was developed over multiple cycles of design, development, and testing which involved students and practitioners representing all relevant fields. The study and design activities were conducted at a Canadian community college and were guided by the Ecological Constructivist framework which evolved as a result of the initial stages of the project. The DBR methodology and the study outcomes are discussed along with the key features and various interdependent components of the MELLES system.

Author Keywords
Mobile-Enabled Language Learning (MELL), English for Special Purposes (ESP), Ecological Constructivism, MALL, Design-Based Research (DBR), contextualized learning

INTRODUCTION
A longitudinal Design-Based Research (DBR) study exploring the design of a Mobile-Enabled Language Learning (MELL) solution resulted in two key outcomes, specifically a MELL system prototype and a set of corresponding design principles. The study addressed the problem of inadequate aural skill acquisition among adult English for Special Purposes (ESP) students at a Canadian community college in Toronto. Previous research identified both aural and oral competencies as critical for students' academic and professional success (Palalas, 2009). The reported interventionist study drew on four years of research which had explored this problem in-situ and identified m-learning, situated in the real-world context, as an appropriate approach for augmenting in-class ESP instruction. Hence, the DBR study sought a flexible solution which, while engaging learners in interactive communicative tasks, would also afford individual listening practice at the time and place convenient for the learner. Moreover, a need for belonging to a community of learners and communicating with peers had to be addressed in the design under investigation. Accordingly, the main purpose of the study was to produce a MELL intervention which would offer flexible contextualized ESP practice - learning that involves interaction with others but at the same time is personalized to learner preferences. Effective utilization of students' own mobile devices as well as working around data plan and wireless connection limitations were two other pieces of the MELL puzzle.

Eighteen months of rigorous data collection and analysis coupled with the design activities resulted in the Mobile-Enabled Language Learning Eco-System (MELLES). The system evolved from individual m-learning object prototypes to a *whole* network of actors, learning tasks and resources integrating the environmental supports with the help of mobile technologies. The evolution of the investigated educational intervention necessitated a revision of the theoretical framework guiding the study. Hence, the initially selected Socio-Cultural Theory was replaced to provide a more holistic and contextual theoretical model required to fit the MELL design advocated by the participant feedback. Ecological Constructivism was thus adopted as the theoretical framework for the remainder of the project. This ecological paradigm demonstrated to be appropriate for MELL design and practice. It melded together all the essential elements of an effective MELL solution which is described in this paper using an ecological lens.

METHODOLOGY
This research adopted the DBR approach which demonstrated to be suitable for this participative interventional study engaging learners and practitioners to investigate educational problems and solutions in their original setting. An overview of the DBR method, its procedures, participants, as well as data collection and analysis activities are presented in the sections below.

Design-Based Research (DBR)
The following definition of DBR captures the salient characteristics of this method as demonstrated through the study:

> 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 & Hannafin, 2005, p. 7)

The inherently multi-cycle process of creating effective technology-based solutions necessitates recursive steps to be carried out over an extended period of time. Accordingly, the outcomes and feedback of the iterative design, development, implementation and evaluation activities were fed back into the successive cycles of the study to facilitate the design of an educational intervention reflecting the requirements of the study participants. At the same time, the participative and collaborative character of the process allowed for interactivity and cooperation amongst practitioners, students, experts, and the researcher. Being grounded in a naturalistic setting and focused on issues of everyday practice, the study resulted in practical solutions leading to reusable design principles. The DBR approach also provided an appropriate framework to examine the complex educational needs and solutions holistically resulting in the design of a multi-component mobile learning system. Lastly, this flexible structure afforded gradual refinement and creation of two interdependent outcomes: the MELLES intervention and the corresponding theory in the form of design principles.

In order to address the complexity of the context and ensure a systematic approach, a proven DBR model was adopted - the Integrative Learning Design Framework (ILDF) (Bannan, 2009). This comprehensive four-stage model offered a methodical framework allowing for "rigorous, research-based cycles within a technology-based instructional design process" (p. 53). The framework comprises four phases: (1) Informed Exploration, (2) Enactment (3) Evaluation: Local Impact, and (4) Evaluation: Broader Impact (out of scope of this research). While the IDLF model guided the macro and micro cycles of the process, the key research question served as the pivotal element of this multidimensional study.

Research question

The overarching research question, repetitively asked at the various stages of the study, inquired what characteristics of the MELL intervention were considered vital for its design to be effective and pedagogically-sound: What are the characteristics of an effective, pedagogically-sound MELLES for students' mobile devices, through which adult ESP students in a community college enhance listening skills, while expanding their learning outside of the classroom?

It is worth noting that, based on the findings of the Informed Exploration phase, the question evolved from its original version and consequently the notion of a learning object was replaced with that of a MELL ecological system. The attribute of being pedagogically-sound referred to an intervention (1) created and evaluated following the main theoretical framework of Ecological Constructivism, and (2) designed to promote learning of listening skills. In terms of the effectiveness of MELLES, it was measured by participant feedback on perceived learning as well as their satisfaction with the design of the intervention and the learning experience.

The intervention was designed for ESP college students studying at the college programs in the area of business, accounting, hospitality, and technology. Using their own mobile devices students piloted MELLES in the streets and at landmarks of Toronto, where they interacted with the tasks and interlocutors in a dynamic language environment, which both supported their language practice and challenged them to make meaning and communicate.

Research design

The study encompassed three phases: Informed Exploration, Enactment and Evaluation: Local Impact. These phases overlapped resembling what in software design would be referred to as an agile approach with the results of both formal and ad-hoc feedback being dynamically integrated into the design. The focus of the first phase was on needs analysis, audience characterization, literature review, as well as the development of the conceptual model and theoretical framework. The Enactment phase concentrated on the design of the prototype, as well as testing and refinement of both the model and the design principles. The third phase, the Evaluation phase, entailed testing, piloting, and evaluation leading to further theory and design refinement. In addition, ad-hoc feedback was exchanged across all cycles of the three phases thus allowing for more responsiveness to changing design requirements. Figure 1 provides an overview of the timelines, main activities, data, participants, and outcomes of the three phases.

Data collection and analysis

Mixed data were collected throughout the project as specified in Figure 1 below. All qualitative data were analysed using the NVivo9 Qualitative Data Analysis System. The manifold iterations of coding and re-coding resulted in several recurrent themes distilled based on their relative frequencies. To reflect participant feedback, these themes were organized into two super-categories: Pedagogy and Technology and indicated the design features deemed by participants as vital for the desired MELL intervention. They were then validated by the quantitative data, collected through the surveys, and analyzed with Excel and the SPSS statistical predictive analytics software. The ensuing findings encapsulated the essential characteristics and elements of MELLES discussed below.

Participants

This interdisciplinary study benefited from contributions and feedback from 163 students (excluding the 191 students from the Mobile Device survey), eight professors from a variety of George Brown College programs — School of Computer Technology (3), School of Design (2), School of Business (1), Centre for Hospitality and Culinary Arts (1) and the Intensive English (IEP) program (1)—as well as two external IT and mobile programming experts. The Digital Design professors contributed their expertise in the design of content for mobile devices as well as in interactive game design. One IEP and three Communications (COMM) professors offered their knowledge of ESP and language learning.

Two School of Computer Technology professors shared their extensive applied knowledge of wireless technologies and mobile programming. Students from the above-mentioned departments were involved in two different roles: two cohorts of Digital Design and Computer Programmer Analyst students as designers and developers, and five groups of IEP and COMM students, representing eight different college programs, participated in the pilots and evaluation of these designs.

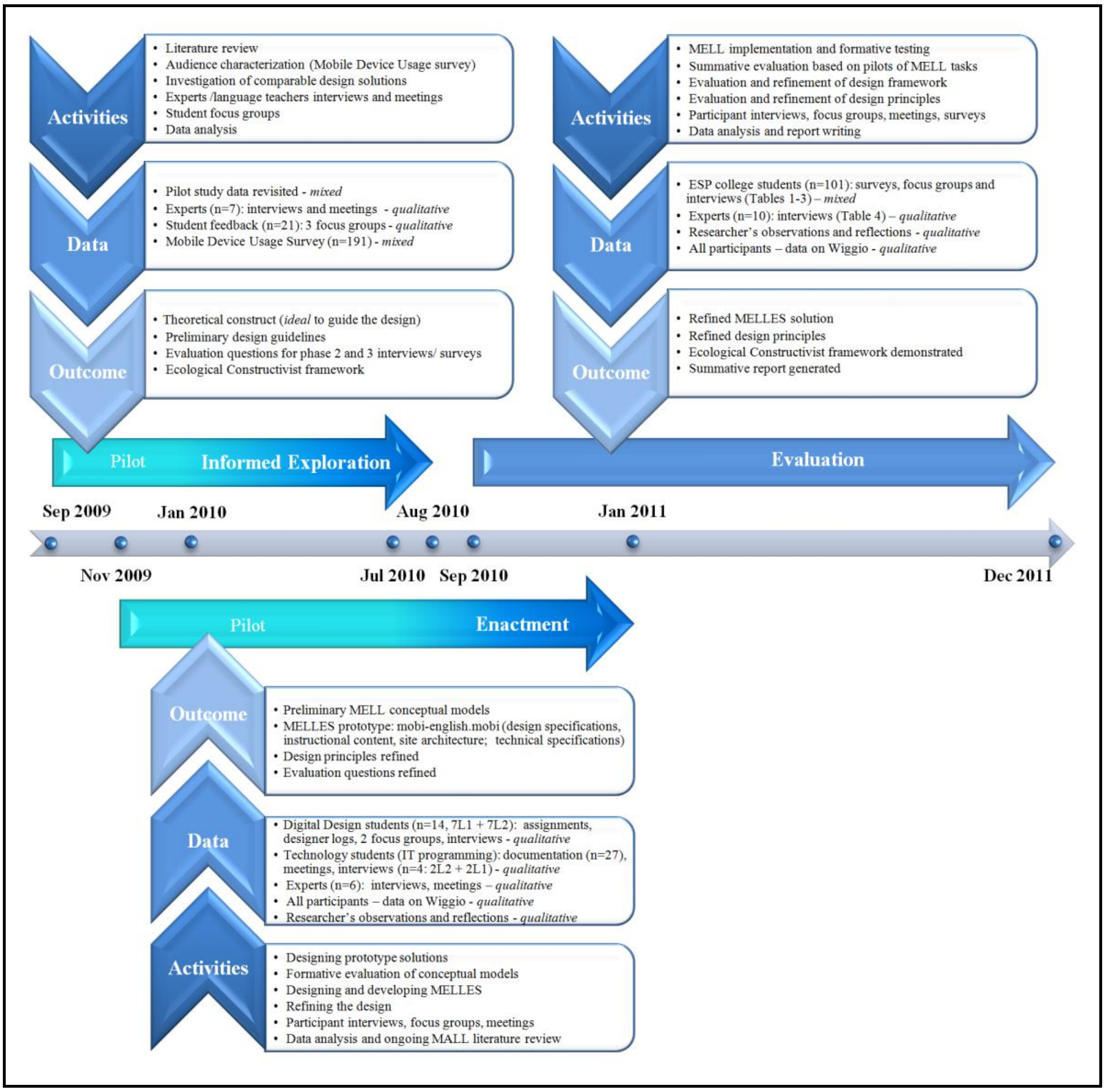

Figure 1. DBR phases: Timelines, main activities, data, participants, and outcomes.

LIMITATIONS

There were two key limitations to the study with the scope of DBR being the principle one. Due to the complexity of the studied system, some of its constituent elements could not be examined in-depth (e.g. cross-platform development). A decision was made to choose the breadth over depth of investigation. Moreover, with respect to measuring MELLES effectiveness, students indicated high satisfaction with the system based on their perceived learning and positive learning experience, but no evidence of learning was collected through formal tests of students' language proficiency.

Other limitations resulting from the nature of the DBR methodology included the overwhelming amounts of data, having impact on data collection and analysis procedures, difficulty managing multiple DBR activities and coordinating participants over the stretch of the study, as well as the intensity, complexity and messiness of the context.

In terms of the researcher role, while she was able to rely on a team of practitioners and experts, the researcher had to wear many hats during the study. She had to assume the roles of an investigator, project coordinator, instructional designer and theorist, software designer, evaluator, m-learning Subject Matter Expert, and negotiator. That resulted in having to assume the conflicting roles of advocate and critic of the MELL design. Another challenge resulting from the joint role of designer and researcher was having to evaluate own intervention designs which put the researcher objectivity and reflexivity to test. The next three sections provide a brief overview of the DBR phases and their key findings.

PHASE 1: INFORMED EXPLORATION

During Informed Exploration, data were collected through mixed methods from students and practitioners who had participated in the pilot of the mobile solution before the DBR study, as well as from Digital Design and Programming students who were working on MELLES prototypes as part of their course assignments. The college-wide Mobile Device Usage Survey was also deployed and its findings enriched the understanding of how students use mobile technologies. The outcomes of this phase formed the basis for the subsequent DBR activities. The *ideal* model was created reflecting the main characteristics of the intervention as identified by the participants. These were translated into the first set of design guidelines. The Ecological Constructivist framework also evolved at this stage.

Phase 1 Findings: Emerging Themes

Starting with the Informed Exploration phase and throughout the two other phases qualitative feedback was captured in text, images and audio files. To conduct rigorous data analysis, all data sources were integrated into the NVivo system, and codes were generated in a cyclical fashion. Thematic codes were assigned to phrases and sentences through repetitive thematic analysis always going back to the main research question. The set of categories and sub-categories that were eventually developed was a result of many coding sessions spreading across the DBR phases with the final set of categories (Table 1) emerging when all the aggregate data was revisited in the final stage of the data analysis. The quantitative results are excluded here for reasons of length and because the subsequent qualitative analysis not only validated the quantitative findings but provided a much more elaborated and informative perspective.

Phase 1 Findings and Discussion: Emerging Ecological Constructivist framework

Phase 1 also produced an ecological framework referred to as Ecological Constructivism (Hoven & Palalas, 2011). The ecological paradigm demonstrated to be an appropriate approach for the exploration of the MELLES system. The specific context of learning listening in the real-world with the help of mobile technologies required a theoretical framework which supported a more holistic and systemic approach to the process of learning - mediated by mobile technology and interaction with other people as well as its context. The Ecological Constructivist metaphor aimed to capture the interconnectedness of psychological, social, cognitive, and environmental processes as well as the co-existence of pedagogical and technological elements interplaying in a dynamic real-life language learning environment. Ecological Constructivism integrates the Socio-Cultural Theory constructs of (1) knowledge co-creation being socially and culturally mediated with the help of tools, and (2) those tools being applied in active learning (3) targeting real-life communicative goals. It also melds Vygotsky's notions of (4) ZPD and (4) scaffolding as well as (4) co-dependence of individual cognition and collaborative learning. It stresses that the fluid nature of the changing context and the active engagement of learners are both required to co-construe knowledge. The notion of context affordances was also introduced and defined as "a particular property of the environment that is relevant—for good or for ill—to an active, perceiving organism in that environment" (van Lier, 2000, p. 252). Accordingly, context affordances mediate the process of learning by providing linguistic cues and other meaning-making supports to those learners who perceive them. Mobile technologies enable noticing the affordances and interaction with those learning supports. All in all, the ecological metaphor emphasizes the wholeness of the MELLES learning system and the interconnectedness of all its elements.

PHASE 2: ENACTMENT

The Enactment phase entailed the design of the successive prototypes, testing and refinement of both the model and the design principles. Digital Design and Programming students as well as practitioners were very active creating, testing and recreating four functional prototypes of the MELLES system. Continuous evaluation of those prototypes, which was part of the concurrent Phase 3, allowed producing the final version of the mobile website which connecting the MELLES users with its resources and functionalities.

Phase 2 Findings and Discussion

The mobi-english.mobi website was constructed using the WordPress Mobile Pack, a reliable cross-platform tool. The website served as a gateway to all MELLES resources, as well as the hub of communication and interaction for learners and their facilitators. Eight listening tasks, which ESP students could access through the website, represented a range of approaches to listening skills acquisition, including individual and collaborative activities, two way communicative challenges and non-reciprocal listening practice. The tasks did not have to be completed in a linear fashion - any one of them could serve as an entry point into the MELLES network. All tasks were related and fed into each other. Following the key principles of ecological thinking—relationships, connectedness, dynamic process and fluid context in which all elements interact to form a web—the prototype solution was designed to encourage collaboration and interaction, thus interlinking the members of the learning community. Consequently, students were asked to complete some of the tasks in groups or pairs. They were also encouraged to co-create multimedia artefacts and evaluate each other's work by leaving comments and rating their audio recordings. Communication was enabled through more traditional channels, such as email and telephone, as well as by blogging, phlogging (blogging by phone), and by exchanging audio recordings.

MELLES included both learning tasks requiring students to be at a particular location and those that could be completed at the time and place of their chosing. Blending learner autonomy with peer and expert support was a significant aspect of how the system functioned. In addition, to provide support in the form of scaffolding, resources and motivation, the system had to be resource-rich and consistently stable. It was the role of the moderator to step in when the instability was apparent. Based on the participant feedback, MELLES was designed to function like an eco-system connecting the actors, resources, and the context of learning at any time, any place, and any point of the learning process. Figure 2 presents two screenshots of the MELLES interface: mobile and desktop.

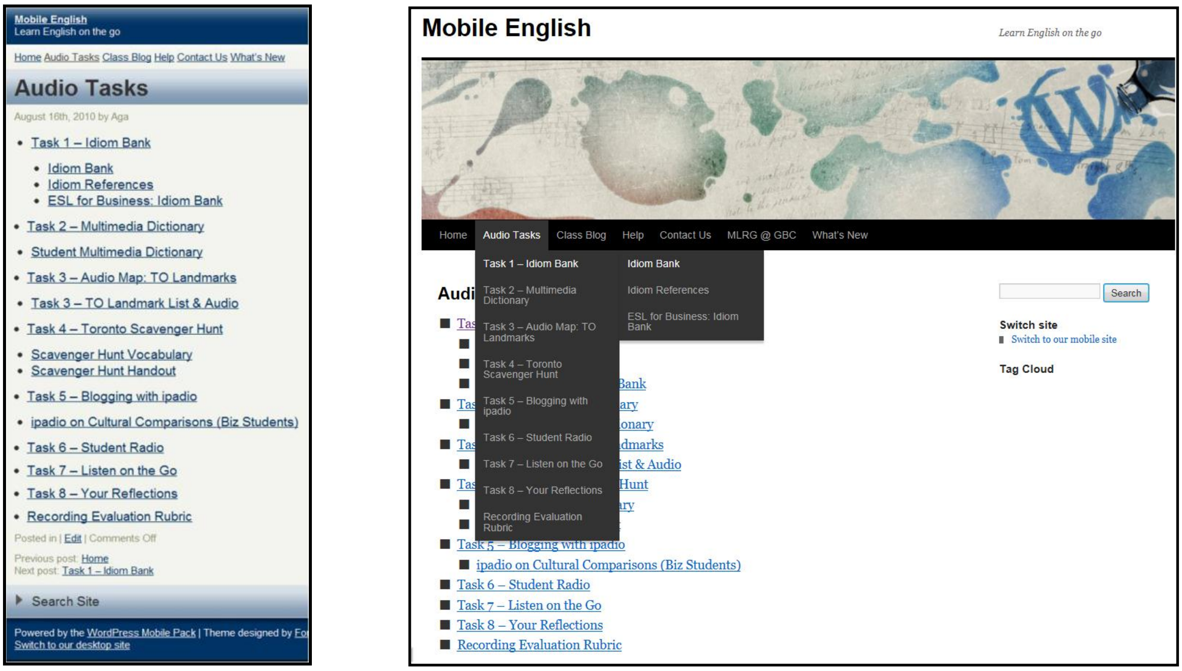

Figure 2. Screenshots of mobi-english.mobi (mobile and desktop interfaces)

PHASE 3: EVALUATION - LOCAL IMPACT

Phase 3 included testing of the MELLES software and piloting the tasks and the complete system by the target users. Speakers of English as a second language from a number of College programs completed the tasks and evaluated the MELLES system. Practitioners and the students, who were involved in the design and redesign of the intervention, also shared their input. As a result of the analysis of that feedback the design and corresponding design guidelines were refined and finalized. The gist of the qualitative data is provided in the table of the most frequent themes below (Table 1). These themes indicate the features and functionalities of the system identified as its most vital elements.

Phase 3 Findings: Key Research Outcomes

The Evaluation phase refined and finalized the following key outcomes:

1. a practical model of a MELL system was created for ESP practice and future studies,
2. the theory evolved to produce the MELLES design principles and the Ecological Constructivist framework, and
3. the DBR method was thoroughly tested and optimized.

Essential Elements of MELLES **Codes (NVivo Nodes)**	Reference Freq Stdnts	Rltv Freq Stdnts	Reference Freq Practn	RltvFreq Practn	**Ref Freq Total**	**Rltv Freq Total)**
PEDAGOGY						
PEDAGOGIC PROCEDURE - How	**444**		**38**		**482**	
Grouping	**164**	***33%**	**14**	***35%**	**178**	***33%**
group work	**120**	***40%***	13	***54%***	133	***41%***
collaboration and peer support	*71*	*70%*	*5*	*63%*	*76*	*70%*
interaction and communication	*33*	*33%*	*4*	*50%*	*37*	*34%*
share learner-generated artefacts	*16*	*16%*	*4*	*50%*	*20*	*18%*
individual practice	31	31%	0	0%	31	28%
pair work	13	13%	1	13%	14	13%
Motivation	**67**	***34%**	**2**	***13%**	**69**	***32%**
motivating factors	30	30%	0	0%	30	28%
fun-enjoyment	37	37%	2	25%	39	36%
Scaffolding - help from teacher	**55**	**54%**	**6**	**75%**	**61**	**56%**
Feedback	**47**	***16%**	**4**	***17%**	**51**	***15%**
need for feedback	18	18%	1	13%	19	17%
classmate feedback	18	18%	1	13%	19	17%
teacher feedback	11	11%	2	25%	13	12%

Listening practice	**38**	**38%**	**0**	**0%**	**38**	**35%**
Recording own voice	**31**	**31%**	**4**	**50%**	**35**	**32%**
Pre and post activities	**28**	**28%**	**6**	**75%**	**34**	**31%**
Integrated skills	**14**	***7%**	**2**	***16%**	**16**	***7%**
need for integrated skills	6	6%	1	13%	7	6%
speaking supports listening	8	8%	1	13%	9	8%
CONTENT - What	**250**		**9**		**259**	
Authentic speech	**58**	***29%**	**0**	***0%**	**58**	***27%**
need for authentic speech	51	50%	0	0%	51	47%
accents	7	7%	0	0%	7	6%
Vocabulary	**31**	**31%**	**3**	**38%**	**34**	**31%**
Directions & explanations	**28**	**28%**	**1**	**13%**	**29**	**27%**
Communication skills	**22**	**22%**	**0**	**0%**	**22**	**20%**
Support materials & resource	**23**	**23%**	**1**	**13%**	**24**	**22%**
Socio-cultural knowledge	**22**	**22%**	**2**	**25%**	**24**	**22%**
Pronunciation	**16**	**16%**	**1**	**13%**	**17**	**16%**
Relevance - work & program related	**15**	**15%**	**0**	**0%**	**15**	**14%**
Listening skills	**22**	***11%**	**1**	***7%**	**23**	***11%**
listening skills - general	14	14%	0	0%	14	13%
listening comprehension	8	8%	1	13%	9	8%
Task length	**7**	**7%**	**0**	**0%**	**7**	**6%**
Variety of topics	**7**	**7%**	**0**	**0%**	**7**	**6%**
CONTEXT - When and Where	**127**		**10**		**137**	
Real-life practice	**59**	**58%**	**4**	**50%**	**63**	**58%**
Outside classroom	**42**	***21%**	**4**	***25%**	**46**	***21%**
outside classroom practice	25	25%	2	25%	27	25%
blended classroom and outside	17	17%	2	25%	19	17%
Context affordances	**26**	**26%**	**2**	**25%**	**28**	**26%**
ACTORS - Who	**38**		**2**		**40**	
Learning community	**38**	**38%**	**2**	**25%**	**40**	**37%**
TECHNOLOGY						
FUNCTIONALITY - How	**75**		**2**		**77**	
Audio player functionality	**31**	**31%**	**0**	**0%**	**31**	**28%**
Audio files quality	**13**	**13%**	**0**	**0%**	**13**	**12%**
Mobile and computer	**12**	**12%**	**1**	**13%**	**13**	**12%**
Text support	**12**	**12%**	**0**	**0%**	**12**	**11%**
Inherent device affordances	**7**	**7%**	**1**	**13%**	**8**	**7%**
TECH CONTEXT - When and Where	**23**		**8**		**31**	
Flexible on-the-move access	**19**	**19%**	**0**	**0%**	**19**	**17%**
Cross-platform	**4**	**4%**	**8**	**100%**	**12**	**11%**

Note. Rltv Freq Total = relative reference frequency -both students and practitioners. (*) = the average of sub-categories.

Table 1. Evaluation qualitative findings—main themes (Essential elements of MELLES)

SUMMATIVE DISCUSSION

The design guidelines distilled from the research data encompassed both substantive and procedural knowledge: they identify the critical characteristics of MELLES as well as strategies required to incorporate these features in the design (Table 2). Due to the scope of this paper, any further discussion of the procedural design principles and the rationale for their inclusion had to be omitted (see Palalas, 2012, for an in-depth discussion of the design principles).

Essential Characteristic (*Substantive Emphasis*)	Strategy (*Procedural Emphasis*)	Rationale (*in order to …)*
2 Learner-generated linguistic artefacts (audio, video, photos, images)	• Include audio recordings (video, images, photos) created by students in response to communicative tasks • Share and showcase learner-generated artefacts • Provide tools for recording, editing, upload and viewing/listening on-the- go (or demonstrate the usage of device built-in tools) • Provide clear directions on creating artefacts • Build in a rating system for artefact evaluation • Accompany website peer eval. by expert feedback • Encourage creativity	• Encourage autonomous and creative learning • Promote meaningful learning through creation, construction, and sharing of artefacts • Enhance individual and group motivation • Support cognitive processes through hands-on construction of artefacts • Blend creativity and competition in learner-generated artefacts exchange • Encourage abstract and creative thinking leading to engagement and motivation • Promote learner ownership and agency

Table 2. Design principle example.

It is worth noting that the participants agreed that none of the individual elements of the MELLES educational intervention could exist on their own, instead they were interconnected and supported each other. For instance, students could not produce any audio recordings (pedagogical principle 2) without the MELLES artefact authoring tools (technological principle 5) or expert facilitation (pedagogical principle 4). Most importantly, the mobile technology was viewed as the glue and enabler of all the pedagogical features which facilitated situated learning and the acquisition of aural skills. The abbreviated substantive guidelines, both pedagogical and technological, are presented below.

Design Principles

The ten pedagogical essential characteristics of MELLES include:

1. Balanced combination of individual and collaborative (group work) tasks;
2. Learner-generated linguistic artefacts (audio, video, photos, images);
3. Game-like real-life communicative tasks;
4. Expert facilitation: scaffolding, feedback, and coordination;
5. Feedback mechanism (immediate and delayed);
6. Focus on authentic listening tasks in the dynamic real-world communicative situations;
7. Support of self-paced individual audio tasks feeding into/preparing learners for the real-life tasks;
8. Integrate all four language skills but focus on listening outcomes;
9. Linguistic resources (task-related): relevant vocabulary, dictionaries, pronunciation, clear task directions and explanations, examples of language usage;
10. Support of out-of-class learning with in-class (f2f) instruction and practice (blending in-class and out-of-class).

To enable the above pedagogical features, the following technological components should be integrated into the system:

1. One-point access to all resources;
2. Exchange and communication platform;
3. Scalability, flexibility and adaptability of the system;
4. Scalable rating scheme (from artefact to learning structures to the whole system);
5. Multimedia (including text) - artefact authoring, management and usage capabilities;
6. Cross platform and multi-technology support;
7. Integrated technology support and tutoring/instruction;
8. Personalized user progress tracking capabilities.

The interdependencies between pedagogical and technological constituents formed a network of relationships which, combined with the actors and the learning context, resulted in the Mobile-Enabled Language Learning Eco-System.

Mobile-Enabled Language Learning Eco-System (MELLES)

The holistic approach encapsulated in Ecological Constructivism put more emphasis on the interdependence of the MELL solution components and the context in which they were intended to be used. The constituent elements of the recommended system need to co-exist for the intervention to promote learning. In fact, it is imperative for the MELLES components to interact and maintain a dynamic balance, as exemplified by the combination of collaborative and individual language activities.

Considering the multiplicity of elements recognized as critical for the effective mobile design, and how they interrelate and support each other, MELLES has to provide a learning environment in which the parts of the system could interact in various configurations promoting the flexibility and evolution of the whole system, and most importantly, enabling seamless mobile learning experience.

Hence, the central feature of the MELLES approach is the coexistence and the relationship of its learning tasks, learners, facilitators, the dynamic language environment in which these tasks are completed, as well as the technology that enables and mediates the learning process and the collaboration between the actors involved in the process. Mobile devices enable communicative exchanges, storage and access to ESP content, learning support and scaffolding. They also help capture linguistic evidence by way of learner-generated artefacts and assist in interaction with contextual affordances used for linguistic action. In addition, the MELLES network of peers, experts and authentic language speakers facilitates learning by means of authentic discourse, feedback, resource sharing and social support.

Additionally, MELLES instruction should encourage dynamic interaction with the English speaking environment to help decode the meaning offered by the real-life language situations. Regular in-class instruction should also be combined with the out-of-class practice and linked into a cohesive learning experience via the MELLES platform and its communication management tools. Furthermore, offering on-demand connection to the system promotes social, cognitive, teaching, and emotional presence (Swan et al., 2008). This results in a collaborative network which has become the predominant structure of the recommended MELLES solution. All in all, MELLES provides mobile access to people, linguistic resources, and context affordances (Hoven & Palalas, 2011) mediating real-life language practice.

Accordingly, new knowledge is generated across the web connecting (1) language, (2) mobile technology, (3) artefacts, (4) learners, experts and (5) other speakers, in (6) a real-life context of learning which all co-mediate the learning process (Figure 3).

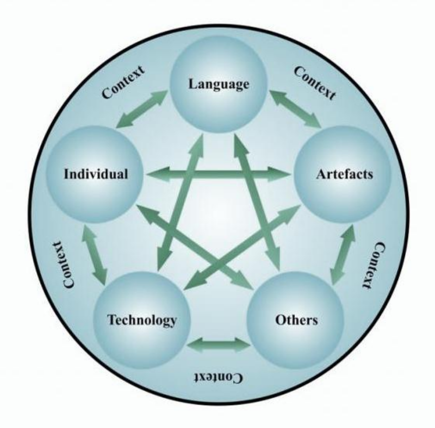

Figure 3. Interconnected elements of the MELLES learning context

SUMMARY AND CONCLUSIONS

Guided by the research question the study resulted in the evolution of theory and practice. The study resulted in a set of replicable design principles to guide the design and development of practical innovative mobile learning interventions. These guidelines are formulated to help practitioners to select and apply the substantive and procedural principles suitable for their specific design in their own contexts.

Guided by current second language learning pedagogy and a Constructivist framework, the original theoretical framework was reconceptualized during the first phase of the study to use a more systemic ecological metaphor. As a result, Ecological Constructivism was proposed as a theory of learning which matched the MELL design requirements emerging from the study. The ecological metaphor offered a holistic lens through which to examine the complex process of learning situated in a dynamic language environment. It also facilitated the investigation of the many dimensions of technology-assisted second language learning amongst adult learners in the out-of-class real-world context. Accordingly, the MELLES approached the learning of listening within the context of *whole* language learning experience, that is, (1) practicing listening as part of a *whole language system* (including four language skills, communication versus grammar, socio-cultural competencies), (2) learning it in the *whole context of students' life* (accommodating their busy schedules and interest), (3) co-construing knowledge as part of the *whole learning community*, and (4) actively practicing listening in the *whole communicative context* of the real-life language situations that learners encounter. The systemic perspective on the MELL intervention stresses the wholeness and connectedness of the constituent parts of the learning context. It also supports *whole* learning by providing mobile tools which connect the learner with facilitators and peers, learning tasks and instructions, linguistic resources and supports, as well as context affordances which learners can perceive.

To that end, the MELLES prototype, offers a network of artefact exchange and communication tools that can be used wherever and whenever. It is an innovative model for learning aural skills in an authentic language setting using learners' mobile devices. It was tested and retested for its applicability in the dynamic, often messy and unpredictable context of language learning. Hence, it provides a practical model for replication in similar educational contexts and further studies.

Finally, the DBR methodology adopted in the study was tested, adjusted, and optimized for the specific environment. In the process, the DBR approach demonstrated to be valid, useful and informative for educational context.

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Mobile Assisted Language Learning: A Literature Review

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ABSTRACT
Mobile assisted language learning (MALL) is a subarea of the growing field of mobile learning (mLearning) research which increasingly attracts the attention of scholars. This study provides a systematic review of MALL research within the specific area of second language acquisition during the period 2007 - 2012 in terms of research approaches, methods, theories and models, as well as results in the form of linguistic knowledge and skills. The findings show that studies of mobile technology use in different aspects of language learning support the hypothesis that mobile technology can enhance learners' second language acquisition. However, most of the reviewed studies are experimental, small-scale, and conducted within a short period of time. There is also a lack of cumulative research; most theories and concepts are used only in one or a few papers. This raises the issue of the reliability of findings over time, across changing technologies, and in terms of scalability. In terms of gained linguistic knowledge and skills, attention is primarily on learners' vocabulary acquisition, listening and speaking skills, and language acquisition in more general terms.

Author Keywords
Mobile assisted language learning, MALL, mobile learning, second language acquisition, mobile technology

INTRODUCTION

Mobile technologies are rapidly attracting new users, providing increasing capacity, and allowing more sophisticated use. This influences cultural practices and enables new contexts for learning (Pachler et al., 2010). The integration of such technologies into teaching and learning has been more gradual, as educators need to understand how they can be effectively used to support various kinds of learning (Kukulska-Hulme & Shield, 2008) and develop effective methods and materials for mobile assisted language learning (MALL), a specialization of mobile learning (mLearning). The main characteristics of mobile learning, such as permanency, accessibility, immediacy, interactivity, situating of instructional activities, are summarized and introduced by Ogata & Yano (2005). While definitions differ, it is obvious that not only technology but also people can be mobile. For the purpose of this paper we define mLearning as a "process of coming to know through conversations across multiple contexts among people and personal interactive technologies" (Sharples et al., 2007, 225) with a focus on contexts. The technology to assist in this process includes any kind of handheld mobile devices such as cell phones, personal digital assistants (PDAs), smartphones, pads, pods, etc. Laptops are today typically not considered mobile in this context, even though they obviously are to some extent. Ogata et al. (2010) state: "computer assisted mobile learning uses lightweight devices such as personal digital assistant (PDA), cellular mobile phones, and so on" (p.8). In the lack of a strict definition, for the purpose of this paper we refer to anything that can be used when walking around.

As mobile technologies provide many advantages: flexibility, low cost, small size and user-friendliness, researchers are exploring how to use mobile technology to support language learning (Huang et al., 2012). However, there are also obvious disadvantages, such as small screen size, limited presentation of graphics (Albers & Kim, 2001), and dependence on networks that may not always provide very high transmission capacity and may be subject to disturbances of many kinds. Despite such shortcomings Thornton and Houser (2005) show that mobile devices can indeed be effective tools for delivering language learning materials to the students. Kukulska-Hulme & Shield (2008) offer a seminal overview of MALL asking whether and how mobile devices support collaborative practice in speaking and listening. The study presented the two main approaches to MALL, content-related and design-related studies. These approaches still dominate in the literature, although the focus is shifting towards design-oriented studies when creating authentic and/or social mobile learning environments (Wong & Looi, 2011).

This review presents an extensive coverage of empirical research, as published in English during the period 2007-2012, concerning the use and effectiveness of MALL in second and foreign language (L2) education with a focus on the methodological, theoretical and linguistic knowledge trends. What theories, research approaches and methods are used when analyzing MALL? Which aspects of MALL are being researched? What are the results so far, and what research gaps are there?

METHOD

The review follows the Webster and Watson (2002) method combining keyword searching and examination of leading journals. First, a set of keywords was identified. Primarily the keywords *mobile learning* together with (AND) *language learning* were used. Further, different combinations of such keywords as *handheld device*, *cell phone*, *mobile phone*, *PDA*, *smartphone*, *mobile, application* together with *language learning* were used. To ensure reliability, search strategies were refined by examining the retrieved articles' abstracts. To further enhance reliability, manual searches were carried out in key journals, including Computer Assisted Language Learning Journal, Computers and Education, Journal of Computer Assisted Learning, Educational Technology and Society and Language Learning and Technology. A further search technique was "snowballing", i.e. following up references in the identified papers and identifying most cited papers. The selection of articles to be included in the review was based on the inclusion criteria presented below. Several international conference papers (such conferences as EUROCALL (European Computer Assisted Language Learning), International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education, mLearn etc.) are also included due to the fact that many of the results of the ongoing projects have not been published yet in peer-reviewed journals as the field of mobile learning with the specific reference to language learning is still in its infancy (Kukulska-Hulme & Shield, 2008).

Papers included were those covering: effects of the use of mobile technology within foreign and second language learning, learners use of technology and attitudes and/or intentions, empirical studies, overview, and/or summary of MALL and CALL (with a focus on the use of mobile technology) research, mobile technology in its relation to language learning within educational settings, published in peer-review journals and conference proceedings in the period 2007 - 2012, effects of technology use on the acquisition of linguistic knowledge and skills (reading, vocabulary learning, writing etc.).

All the identified articles and conference contributions were analyzed in order to assess the papers' quality in terms of the applied theory, approach, method, and themes, using the Grönlund & Andersson (2006) model. After retrieving the relevant literature, the abstracts and the findings/conclusions of the articles were examined. Secondly, approach and method was examined so as to assess the credibility of the claims in the papers. Thirdly the main concepts were identified and organized in an author-centric matrix suggested by Webster and Watson (2002). Finally, the papers were examined to identify the language skills' focus when using mobile technologies in second language and foreign learning and teaching. As most of the reviewed articles were retrieved from highly ranked and cited journals, the methods and approaches employed could be trusted for their quality and credibility. Initially 89 papers were found. 54 of them fulfilled the selection criteria and are thus included. The categories for the analysis of research type and method used were adapted from Grönlund and Andersson (2006).

FINDINGS

Research Approach

In our sample most research was descriptive (44 %), presenting various cases where technical appliances were used. We found only one theory generating study and no theory testing one (Table 1). Theories were used in 46 % of the papers, but mainly to illustrate or interpret findings. We found only one theory specifically designed to cover the MALL field (Sharples et al., 2007). Noticeably, several descriptive studies also include elements of philosophical or theoretical concepts or models.

Descriptive	Describes a phenomenon in its appearance without any use of theory.	24	44%
Philosophical	Reflects upon a phenomenon without data and any use of theory.	2	4%
Theoretical	Reflects on a phenomenon based on some theory but without empirical data	2	4%
Theory use	Applies a theory/theories & models as a framework for the conducted study	25	46%
Theory generating	Attempts to analyze quantitative/qualitative data in a systematic manner with the use of theory with a purpose of (taking steps towards) theory building	1	2%
Theory testing	Attempt to test a theory using quantitative or qualitative data in systematic manner, i.e. just strict theory testing.	0	0%
Total		54	100%

Table 1. Research approach

Method

The most commonly applied method is experiment, with 47 % of the papers (Table 2). Second most common are interpretive studies (28 %). This indicates that the MALL field is in an emerging phase, still under development and in need of more solid empirical evidence in order to underpin theoretical conclusions about how mobile technologies can assist language learning and in order to build theoretical models that are specific to this scientific field.

A significant number of studies illustrate for MALL specially designed intelligent systems for individuals' use when practicing different language skills (Chang & Hsu, 2011; Chen & Chung, 2008; Chen & Li, 2010; Huang et al., 2012; Kaneko et al., 2008 etc.), such as use of Artificial Intelligence methods and technologies. In experiments, use of such systems is frequently compared to a 'traditional' way of teaching and learning a language in educational settings, attempting to show results of the developed software's use on, among others, individuals' second language vocabulary acquisition, listening and/or speaking skills etc. Thus most of these studies present explorative and comparative knowledge. Additionally when exploring learners' intentions and attitudes towards the use of the proposed systems and applications, evaluative knowledge is offered.

Method	**Description**	**Number of articles**	**%**
Argument	Logical argument but not based in any particular theory or relating explicitly or by clear implication to any theory.	2	4%
Case story	Tells about a case but as opposed to a case study there is no strict data collection method.	4	6%
Ethnography	Any attempt to understand actions by systematic observation and interpretation.	0	0%
Experiment	Field experiments included.	25	47%
Grounded Theory		1	2%
Interpretative	Any kind of more strictly performed data collection than a "case story" but not necessarily strictly explained or spelled-out method for interpretation. Case study belongs here but also more limited studies where qualitative and quantitative data is used.	15	28%
Literature study	Only documents used (scientific, policy documents etc.). Not necessarily strict method or even explicitly labeled as literature study	1	2%
Product description	IT product, method or similar, described by the manufacturer or someone else.	4	6%
Survey	This covers also qualitative overviews of several documents and cases.	1	2%
Unclear	Even the widely defined categories above fail to capture the method.	1	2%
Total		54	100%

Table 2. Method

Theories

The theories and models applied in the reviewed literature most often originate from previously established theories of learning, such as constructivism and situated learning theory. The experiments in the reviewed papers are hence typically applied on mature pedagogy. There are, however, also a few studies discussing mobile learning or Mobile Learning Theory or even Modern Mobile Learning Theory in attempts to formulate field-specific theory. There are also more general theories used, such as Activity Theory and Sociocultural Theory. Some theories originate from psychology, such as Cognitive Load Theory and Dual Coding Theory, and some relate directly to technology use, e.g. the commonly used Technology Acceptance Model (TAM). Many papers, however, do not exhibit any clear theoretical background.

Research Content

Analyzing the research topics of the papers, three major categories were found: 'technological concepts of learning' (e.g. Mobile-device supported peer-assisted learning), 'technology-centered concepts' (e.g. SMS –based learning), and 'learning environment' with two subgroups: 'theoretical development' (e.g. Contextualized meaning making) and 'practical aspects' (e.g. Usefulness). Table 4 provides a complete list and shows that most specific concepts, in particular those concerned with theory, are used only in one or very few papers.[1] Only general concepts like MALL are widely shared. This means there is little cumulative research.

Thematic categories	**Examples**	**Concepts**

[1] References in the table are available from the author. Excluded due to lack of space.

Technological Concepts of Learning	Anderson et al. (2008)	Language learning outside the classroom
	Chen & Li (2010)	Context-aware ubiquitous learning
	Chen & Chung (2008); Hsu et al. (2008); de Jong et al. (2010); Cheng et al. (2010); Oberg & Daniels (2012); Petersen et al. (2011); Sandberg et al. (2011); Huang & Sun (2008); Hwang & Chen (2011); Abdous et al. (2012)	Mobile learning
	Chang & Hsu (2011)	CALL
	Comas-Quinn et al. (2009)	Constructivism, situated learning, informal learning
	de Jong et al. (2010); Hsieh et al. (2010); Petersen et al.(2011)	Situated learning
	de Jong et al. (2010)	Knowledge gain
	Demouy & Kukulska-Hulme (2009)	Authentic learning
	Fotouhi-Ghazvini (2009)	Game-based learning
	Hsu (2012)	MALL from cross-cultural perspective, constuctivism
	Huang et al. (2012); Liu (2009); Chen & Li (2010); Cheng et al. (2010); Fallahkhair et al.(2007)	Ubiquitous learning
	Kukulska-Hulme & Shield (2008); Kukulska-Hulme (2009); Miangah & Nezarat (2012); Nah (2011); Wong et al. (2010); Hsieh et al. (2010)	MALL
	Kukulska-Hulme (2010)	Learner-led innovation
	Lan et al. (2007)	Mobile-device supported peer-assisted learning
	Li et al. (2010)	Adaptive learning
	Liu et al. (2008)	Communicative mobile English learning
	Liu (2009), Cheng et al. (2010)	Collaborative learning
	Liu (2009)	Immersive learning
	Oberg & Daniels (2012)	Self-pace instruction
	Sandberg et al. (2011)	CALL, informal learning, game-based learning
	Stockwell (2007, 2008)	CALL
	Wong & Looi (2010)	Seamless language learning design
Technology-Centered Concepts	Abdous et al. (2009, 2012); Ducate & Lomicka (2009); Rosell-Aquilar (2007)	Podcasting
	Cavus & Ibrahim (2008, 2009); Katz & Yablon (2011); Lu (2008); Kennedy & Levy (2008); Saran et al. (2008)	SMS –based learning
	Chang & Hsu (2011); Chen & Chung (2008);Chen & Li (2010); Huang et al. (2012); Kaneko et al. (2008); Petersen & Markiewicz (2008); Stockwell (2007, 2010); Cheng et al. (2010); Sandberg et al. (2011)	Usage of multimedia/hypermedia intelligent systems
	Cheng et al. (2010)	Exchange of ideas through presentations
	Comas-Quinn et al. (2009); Hsu et al. (2009)	Mobile blogs
	Godwin-Jones (2011); Chang & Hsu (2011); Chen & Chung (2008); Chen & Li (2010); Fallahkhair et al. (2007); Huang et al. (2012); Liu (2009); Petersen & Markiewicz (2008); Petersen et al. (2011); Sandberg et al.(2011); Stockwell (2007, 2008, 2010); Huang et al. (2012)	Mobile applications for language learning
	Gromik (2012), Nah (2011); Fallahkhair et al. (2007)	Learning with a cell phone
	Fallahkhair et al.(2007)	Language learning support via iTV and cell phones
	Jian et al. (2009)	Electronic pocket dictionaries
	Li et al. (2010)	Mobile-based e-mail learning (MESLL)
	Liu (2009)	Sensor and handheld augmented reality(AG)-supported ubiquitous learning
	Nah (2011)	WAP site’s use for listening activities
	Sandberg et al. (2011)	Added value of mobile technology for learning English

	Song & Fox (2008)	Referential use of mobile devices (PDAs) to enhance learners' incidental vocabulary learning
Learning Environment Theoretical Developmental	Chen et al. (2008)	Content adaption in mobile learning environment
	Comas-Quinn et al. (2009)	Intercultural awareness; interface between learner and context
	Cheng et al. (2010)	Contextual familiarity
	de Jong et al. (2010)	Contextualized language learning
	Huang et al. (2012)	Interactive learning environment
	Hwang & Chen (2011)	Familiar context
	Wong & Looi (2010)	Contextualized meaning making
Learning Environment Practical Aspects	Petersen & Markiewicz (2008); Kukulska-Hulme (2010); Chen & Chung (2008); Chen & Li (2010)	Personalization
	Cheng et al. (2010)	Playfulness
	Comas-Quinn et al. (2009); Kukulska-Hulme (2010); Hsu (2012); Abdous (2009, 2012); Fallahkhair et al. (2007)	Learner-centeredness
	de Jong et al. (2010)	Desirability
	Huang et al. (2012); Chen & Li (2010), Cheng et al. (2010); Chang & Hsu (2011)	Usefulness/ease of use
	Hwang & Chen (2011)	User's percipience
	Cheng et al. (2010)	Student's engagement

Table 3. Concepts used

DISCUSSION AND CONCLUSIONS

This review sought to offer a general picture of research trends in MALL with a focus on second and foreign language acquisition published since 2007 in terms of research approaches, methods, theories and models, and results.

What Research Approaches and Methods Are Used When Analysing MALL? The scientific field of mLearning and MALL generally, as well as L2 acquisition specifically, are emerging so unsurprisingly we found a large number of approaches and theories employed. Most of these originate from other areas, such as applied Cognitive Load Theory (Oberg & Daniels, 2012) and Dual-Coding Theory (Huang et al., 2012) derived from the cognitive psychology; TAM (Cheng et al., 2010) from informatics research, and a number of learning and language acquisition theories. A number of studies introduce mobile learning, MALL and even the Theory of Mobile Learning but it is often not clear how these new concepts differ from other technology-enhanced learning perspectives, for example e-learning or CALL. In general, theories are vaguely used; we found only one theory generating study (Liu et al., 2008) and no theory testing one. The dominating research approaches within MALL for the reviewed years are descriptive studies (44 %) and what we call "theory based studies" (46%), where the authors present a theory which in some way is related to their experiments or case studies. For example, de Jong et al. (2010) employ sociocultural perspectives, where emphasis is on the social motive for second language learning. There is often a lack of a clear connection between the theory and the discussion part in the reviewed papers. There are exceptions, e.g. TAM which is strictly operationalized, but then there may be other gaps; TAM, again, is not related to learning, only to use of technology.

As for the descriptive studies, a typical example is Godwin-Jones (2011) who illustrates the state of language learning applications, the devices they can be applied to, and how they are developed. The descriptive studies often include embryonic elements of philosophical or theory generating categories. For instance, the research conducted by Kukulska-Hulme (2009) describes findings from previous research and reflects upon the phenomenon of MALL without any explicit use of theory.

'Experiment' (non-strictly defined) is the most commonly applied method in the reviewed studies (47 %), followed by interpretive case studies (28 %). Together these two methods make up 75% of the research published 2007 – 2012. Most studies are small-scale, exploratory, and conducted within a short period of time, which makes them rather anecdotal in terms of reliability. This is not surprising given that the field of MALL is in its developmental experimental phase and still needs more solid empirical evidence and guidance in order to underpin conclusions about how mobile technologies can assist language learning acquisition and in order to build theoretical models specific to this field. It is hence still an open question to what extent MALL in the L2 area is indeed different from MALL in other areas.

Within What Theoretical Frameworks the Studies Have Been Carried Out? Theory use in the sample is very scattered. A large number of theories were found but most theories appeared only in one paper; we saw no cumulative theory use. Notably, many concepts appear only in one or a few papers. As one commonly cited criterion of a scientific field is that a common set of theories is applied, this finding indicates that MALL is yet only a potential field, united mainly by the studies of mobile technologies.

However, despite this character of being an emerging research field undergoing a rapid evolution there are already attempts to create field-specific theory. Sharples et al. (2007) introduces the Theory of Mobile Learning which examines how (mobile) learning stretches across locations, times, topics, and technologies. According to this theory, which is discussed and extended in several papers (Sandberg et al., 2011; Petersen et al., 2011; Hsieh et al., 2010 etc.), learning which takes place in one context can become a resource in other contexts. This effort of creating theory indicates attempts to distinguish the MALL field from other scientific learning areas and theories by raising and discussing its own theoretical perspective. Our study finds that there is, as yet, a lack of specific reference to mobile learning conceptual frameworks and theoretical models, which makes it difficult to clearly distinguish the theory of mobile learning from other learning theories and approaches. MALL theory development is work in progress.

The theories and models applied in the reviewed literature on MALL often originate from grand theories of learning, including constructivism, social constructivism. Activity Theory and Sociocultural Theory are examples often mentioned by studies on MALL (Nah et al., 2008, de Jong et al., 2010). One of the most fundamental concepts of Sociocultural Theory is that the human mind is *mediated* (Lantolf 2000). This mediation is often assisted by the tool use. Hence mobile technology use plays a dominant role in the process of meaning making in terms of mediated nature of human mind. MALL research often employs learning theories where such mediation is an issue, including Situated Learning Theory (Hsieh et al., 2010, Hwang & Chen, 2011), collaborative learning (Chang & Hsu, 2011; Lan et. al., 2007), self-paced learning (Oberg & Daniels, 2012), and seamless learning integrating formal and informal ways and contexts of learning (Wong et al. 2010; Wong & Looi, 2010).

In order to investigate learners' perceived ease of use, perceived usefulness, intentions, and attitudes towards the use of mobile technologies for language learning, TAM, an established theory for this purpose, is commonly applied (Chang & Hsu, 2011; Huang et al., 2012). Most studies show that learners have a positive attitude towards the use of mobile technologies for the second and foreign language acquisition, but there are differences. For example, Huang et al. (2012) show that the designed system (ubiquitous English vocabulary learning system, UEVL) was readily accepted by the students in the sample but while active students were concerned about the perceived usefulness of the system, passive ones were more concerned about the perceived ease of use of the system.

There are theories emphasizing cognitive aspects of learning, such as the Cognitive Load Theory (CLT) which measures the limits of people's working memory capacity in order to investigate individuals' working memory load when, for example, using different specially designed intelligent systems for mobile devices for language learning (Chen et al., 2008; Chen & Chang, 2011; Oberg & Daniels, 2012). Other models applied in the reviewed papers include Moderation Model (Chen & Chang, 2011), Working Memory Model (Chen et al., 2008), and Structural Model (Huang et al., 2012). A number of papers, however, do not have any clear theoretical background but are rather descriptive.

Despite the fact that many authors mention and make an attempt to define mLearning and mLearning theory in the introductions to their studies, it is often unclear how these concepts and theories are operationalized.

What Aspects of MALL Are Being Researched? Studies analyzing the mobile technology's use in the different aspects of language learning have supported the idea that mobile technology can enhance learners' second and foreign language acquisition. Learners' attitudes towards technologies, their intention to use it, and the various actual uses of mobile technology integrated in their second and foreign language learning is a dominating research focus (Chang & Hsu, 2011; Cheng et al., 2010 etc.). The impact of mobile technology on language learning has often been measured by individuals' stated perceptions. This exemplifies what Orlikowski & Iacono (2001) call the *proxy* view of technology. Effectiveness studies focus on how this technology is viewed by individual users where the perceptive, cognitive, and attitudinal responses to technology become the critical variable in explaining mobile technology. This *tool* view of technology is criticized as it fails to take into account the transformational nature of technology; technology brings with it changes not only in procedures – how we do things – but also in our perceptions of what is doable or not, e.g. in terms of accessing distant materials and people. Hence technology itself plays a role in reshaping people's preferences, perceptions, and attitudes and the new teaching and learning methods that evolve are co-constructed in a sociotechnical system rather than engineered. This is called the *ensemble* view of technology (Orlikowski & Iacono, 2001), and this idea of sociotechnical construction – as opposed to purely *social* construction – is something often lacking in MALL studies.

Three key themes have been identified. First, *technological concepts of learning*, where the mobile learning and specifically MALL are often seen as the separate forms of learning together with more established learning theories like constructivism and collaborative learning. A number of other approaches to learning such as situated learning, mobile learning; authentic learning, self-paced learning are discussed when investigating individuals' adoption and integration of mobile technologies in their language learning.

Second, *techno-centered concepts* focus on technology itself as a means of communication between the learner and the content as well as teacher and learner where a shift from sms-based learning towards the development and use of mobile language learning applications in form of intelligent multimedia tutorial systems is noticeable. Finally, the *learning environment* theme focuses on theoretical development and practical aspects of such environments. Much attention is paid to the different contexts of formal and informal learning, and how mobile technologies are available and can contribute to the individual's language learning acquisition in these different situations.

Despite the fact that a number of authors attempt to define and use the concept of MALL as an independent scientific field, language learning with the support of mobile devices is often seen as a part of CALL (Chang & Hsu, 2011; Sandberg et al., 2011 etc.), mobile-(assisted) learning (Hsu et al., 2008; de Jong et al., 2010). This conceptual ambiguity indicates that the field of MALL needs more conceptualized knowledge in the form of field-specific definitions, theories, models, and solid evidence on how the use of mobile technology can assist second and foreign language acquisition.

In What Ways does the Use of Mobile Technology Facilitate the Acquisition and Development of Linguistic Knowledge and Language Skills? In terms of the gained linguistic knowledge and skills, most of the reviewed papers examine vocabulary acquisition, listening and speaking skills, and language acquisition in more general terms. The review finds several suggestions for language learning benefits in the use of MALL, such as integrating the mobile technology in both formal and informal contexts; the 'fun' moment when engaging learners in authentic learning contexts; the learners' contribution to the creation of the learning content; the use of mobile devices to support the practice of achieving listening and speaking skills effectively etc. Often the usefulness of the mobile technology use for vocabulary acquisition is measured by surveying learners' attitudes. There are also a number of studies attempting to analyze the outcome in terms of learners' language proficiency. However, as most studies are implemented within a short period of time and involve a small number of participants, results are yet inconclusive in this respect.

Studies focusing on grammar learning, pronunciation and writing skills are underrepresented in the reviewed literature. However there are the papers which analyze mobile technology applications on language acquisition in general terms (Rosell-Aguilar, 2007; Fallahkhair et al., 2007; Petersen & Markiewicz, 2008, Liu et al., 2008; Cheng et al., 2010; Abdous et al., 2012; Oberg & Daniels, 2011; Hsu, 2012), often indicate positive attitudes towards the mobile technology use and suggest better results in terms of language proficiency. Very little attention is devoted to individuals' language learning strategies and learning styles when employing mobile devices for their language learning. This knowledge can have a crucial impact on both educators, when for example designing language learning activities adopting mobile devices (development of new applications and intelligent tutorial systems for mobile devices for language learners) and learners, as they can achieve higher proficiency.

Are There Research Challenges in the Field of MALL Research that Require Further Investigation and What Can Be Suggested for the Further Research? There is a lack of empirical studies providing concrete evidence on how the mobile technology use can enhance individual's language learning results. In order to ensure reliability longer studies and larger test groups are required.

In terms of language knowledge and skills, more experimental cases testing more specifically how mobile technology can assist and improve learners' writing process, reading comprehension, pronunciation performance, and second language grammar acquisition are needed.

Moreover, empirical research investigating the possible changes in individuals' learning strategies when employing mobile devices in their language learning is needed in order to be able to make the language acquisition process more effective and to be able to influence the second and foreign language proficiency results. It would also be beneficial to analyze the interconnection between individuals' learning strategies, learning styles, and use of mobile technology. Such knowledge would make an important contribution not only to educators and learners but also to systems developers.

From a pedagogical point of view, research on how the use of mobile technology affects individuals' time management when learning a new language is needed to understand if this technology can open additional learning possibilities, for example in terms of engaged time.

Overall, more theory generating research developing mobile learning theory and constructing new theoretical models in MALL is needed to be able to distinguish the field from other kinds of technology-assisted learning, such as CALL.

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Evaluating 'ThinknLearn': A Mobile Science Inquiry Based Learning Application in Practice

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ABSTRACT

There is growing interest from science educators and researchers to develop technology-assisted inquiry based learning environments in the domain of school science education. Traditionally, school science education has been dominated by deductive and inductive styles of enquiry investigations, while the abductive style of inquiry investigation has previously been sparsely explored in the literature related to technology enhanced learning. We have therefore designed and evaluated a mobile learning application „ThinknLearn" for the abductive style of inquiry investigation. This study uses the M3 evaluation framework for evaluating this application with high school science students. The results indicated in this paper showed improvements in the students" understanding of the learning domain as well as developing their positive attitudes towards mobile learning.

Author Keywords

Abductive, inquiry based learning, mobile learning, science education, technology-assisted learning

INTRODUCTION

Inquiry based learning is a pedagogical approach in which learners get knowledge through exploration and investigation with authentic situations, and develop their higher level thinking skills (Lim, 2004; Shih et al., 2010). It is suggested that these learning activities foster learners" motivation and interest in science (van Joolingen & Zacharia, 2009). Rapid advances in digital technology have increasingly attracted the interest of science educators and researchers for developing systems to support learning experiences about the sciences. In recent years, the use of mobile technologies has increasingly supported access to web-based contents on-the-go "anywhere, anytime" because of their portability (Svetlana & Yonglk-Yoon, 2009). Further, these technologies not only support the learning experience inside the school (e.g. lab, classroom, library) but allow learners to perform inquiry based learning activities in natural environments (e.g. park, woodland, museum) (Rogers et al., 2005). This is due to the affordances of these technologies that offer many different levels of engagement (Looi et al., 2010). This makes it possible to build learning environments that can enable inquiry based learning activities in multiple contexts.

In the literature related to school sciences, a number of mobile science inquiry based learning applications have been discussed which reflect the diversity of inquiry investigations and their use in both indoor and outdoor settings. Among these, the Ambient Wood Project (Rogers et al., 2005) and Savannah (Facer et al., 2004) are well-known mobile science projects in which learners are engaged in science learning activities by exploring virtual or natural environments in outdoor settings. There are some other recent mobile science projects in which learners are involved in both indoor and outdoor learning activities such as LET"s Go! (Vogel et al., 2010) and nQuire (Sharples et al., 2011). For indoor school settings, BioKIDS Sequence (Parr, Jones, & Songer, 2004) and WHIRL (Yarnall, Shechtman, & Pennel, 2006) use mobile technologies in science classrooms in order to support more frequent assessment practices.

There are many studies (Chen et al., 2008; Huang, Lin, & Cheng, 2010; Shih et al., 2010) showing that the participants enhanced knowledge significantly when they were equipped with mobile learning applications as compared to the traditional ways of science learning. Specifically to hypothesis formation activities, there are some studies found in the literature that highlight the importance of technology-assisted environments which can help students to construct scientific hypotheses and their explanations during science inquiry investigations (Mulder et al., 2010; Oh, 2011; Peker & Wallace, 2011).

Most of these mobile science learning applications follow a hypothetico-deductive or inductive means of inquiry investigation in which learners are required to process ideas (or hypotheses) (Grandy, & Duschl, 2007). In contrast, abductive scientific inquiry emphasizes the development of hypotheses observed from the natural environment (Oh, 2011). In the technology enhanced learning literature, this kind of inquiry has not been previously exploited (Grandy & Duschl, 2007; Oh, 2011). Since no previous studies have demonstrated the benefits of mobile learning in hypothesis formation activities in the context of abductive science inquiry investigations, this provides us with an opportunity to explore some new approaches to technology-assisted learning in the sciences.

ABDUCTIVE SCIENCE INQUIRY

In inquiry based learning, one of the important learning activities is to provide scientific explanations of natural phenomena. An abductive science inquiry is also implemented in a similar way that leads learners towards new explanations on the basis of background theories and observations (Raholm, 2010). In this trait of inquiry, learners are not sure about the conclusions but they get some possible explanations of a given problem, and those potentially possible explanations guide learners to construct some meaningful learning (Eriksson & Lindstorm, 1997). Substantially, this is the essence of abduction that it starts with the incomprehensive nature of explanation and concludes with the construction of satisfactory new knowledge by relating observed phenomena and the underlying concepts of a given domain (Raholm, 2010).

The concept of abduction was coined by C.S.Peirce (1839-1914) who classified abduction as a form of inference. He further explained that the logic of scientific inquiry is divisible into three fundamental modes of inference (Raholm, 2010): (1) deduction or explicative inference (2) induction or evaluative inference and (3) abduction or innovative inference. The following example, taken from our domain of study, will show the relationships more clearly. Here, the ideas relate to black surfaced tins (cans) containing hot water losing heat more quickly than white or shiny surfaced tins. In these examples, the Case (Hypothesis), Result (Observation) and Rule (Condition or Suggestion) are defined to show the differences in order.

Deduction:
Rule–The water particles in a black surfaced tin vibrate faster than the other tins.
Case– A black surfaced tin absorbs more heat energy than the other tins.
Result–A black surfaced tin cools more quickly.

Induction:
Case–A black surfaced tin absorbs more heat energy than the other tins.
Result–A black surfaced tin cools more quickly.
Rule–The water particles in a black surfaced tin vibrate faster than the other tins.

Abduction:
Rule–The water particles in a black surfaced tin vibrate faster than in the other tins.
Result– A black surfaced tin cools more quickly.
Case– A black surfaced tin absorbs more heat energy than the other tins.

From these examples, it can be observed that in both deduction and induction, a Case (Hypothesis) is processed with either a Rule or a Result to generate the other component, while in abduction, the Rule and Result are used together to find a Case. This trait of abduction is well-suited to inquiry problems in which learners are challenged to formulate scientific hypotheses and explain natural phenomena (Oh, 2011). Therefore, science educators and researchers have recently begun to study the process of hypothesis generation in the context of abductive inquiry investigations.

THINKNLEARN: A MOBILE WEB APPLICATION

In consultation with the science teachers from a local high school, we agreed on one of the science inquiry topics from the national standard science curriculum as the experimental context to test a mobile learning application that supports abductive inquiry. In this experiment, three tins with different surface colours are filled with boiling water in order to compare the way they radiate heat energy. Tin A is painted white, tin B black and tin C is shiny (unpainted). Learners have to formulate a hypothesis from collecting data about these tins and then explain it further as depicted in Figures 1a and 1b (further details about the application can be found in Ahmed, Parsons & Mentis (2012)).

This mobile web application „ThinknLearn" follows the AIM (Abductive Inquiry Model) (Oh, 2011) which includes four phases; *exploration*, *examination*, *selection* and *explanation*. In the *exploration* phase, the application asks about the temperature of the various tins which were recorded by the students at a particular time interval after pouring boiling water in these tins as shown in Figure 1a. After submitting all values for the given tins, the application poses a series of Multiple Choice Questions (MCQs) regarding the collected values of these measures one-by-one in the *examination* phase. This feature makes students use their observational abilities to answer the given questions. Further, it gives suggestions based on the answers chosen by the students. This question-suggestion module of the application guides students towards a point where they are able to formulate hypotheses about the given measures and understand the knowledge presented in this application. These context-sensitive suggestions are generated from an ontology which may lead the students to think about the various aspects of heat energy related to different coloured surfaces. The ontology is used for the representation of the domain of interest (Uschold & Gruninger, 2004).

In the *selection* phase, students are asked to select one of the appropriate hypotheses about the observed phenomena as depicted in Figure 1b. There are two hypotheses defined in this application; one is related to the vibration of the water particles and the loss of heat energy from the different coloured tins while the second is about the heat absorption and the loss of heat energy from the different coloured tins. The application uses a random function to ask about one of these hypotheses. In addition, the application extracts all the possible hypotheses including one correct and other three distracters by using the domain ontology and its inter-related concepts. At the end, students express their complete explanations of the observed phenomena in the *explanation* phase.

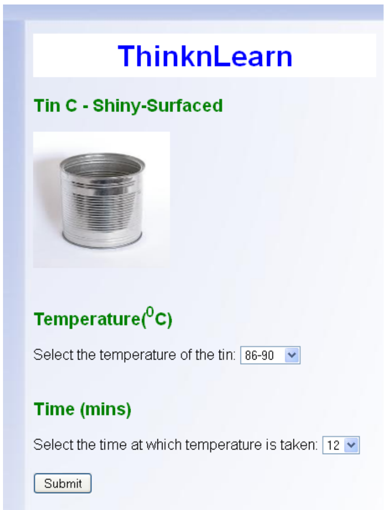

Figure 1a Measurements recorded for a shiny tin

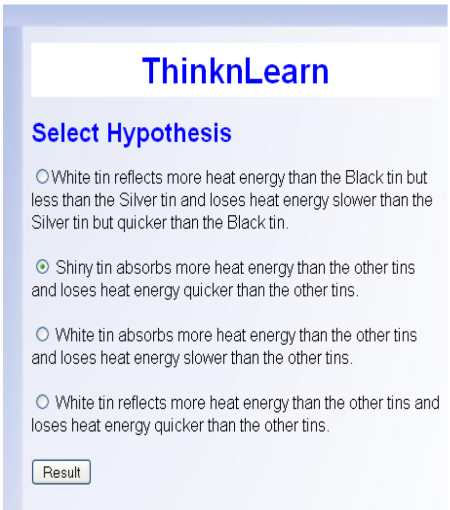

Figure1b Hypothesis selection

EVALUATION

It is suggested in (Sharples, 2009) that mobile learning applications evaluation can inform systems by examining how the learning activity and the underlying technology can be developed to enhance learning and offer new learning opportunities. For the purposes of evaluation, part of the M3 evaluation framework (Vavoula et al., 2009) is used in this study. This framework consists of three levels of granularity (Vavoula & Sharples, 2009); Micro, Meso and Macro. However, in this study, only two levels (i.e. Micro and Meso) are applied as defined in Table 1. The reason for not considering the Macro level at this stage is because this level is used to examine the longer term impact of the new technology on established learning practices (Vavoula et al., 2009). At this stage of the research, this level of evaluation is not yet possible.

M3 Evaluation Framework Level	Evaluation Aspects	Form of Evaluation
Micro Level	• Technology usability • Individual and group learning activities (Hypotheses Formation)	• Questionnaire • Semi-structured group discussion
Meso Level	• Mobile learning experience as a whole • Learners" cognitive skills and learning performance	• Pre-Post tests (Experimental and Control groups)

Table 1 Evaluating 'ThinknLearn' using the M3 evaluation framework

Experimental Design

The rationale for this experimental design is to evaluate „ThinknLearn". Evaluation at the Micro level includes the technological usability and utility of the application. The utility covers the guidance towards the construction of hypotheses about the underlying domain while the usability focuses on the capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions (Bevan, 2001). Three ISO metrics including *learnability*, *operability* and *understandability* are used (ISO, 2003) for that purpose. In addition, for exploring the quality of learners" learning experiences in a mobile learning context, three „softer" metrics of quality are applied; *metaphor*, *interactivity* and *learning content* (Parsons & Ryu, 2006). These aspects are used in order to identify the quality of the learning experiences of the learners during such mobile learning activities (Parsons & Ryu, 2006).

Evaluation at the Meso level explores learners" educational aspects such as mobile learning experiences, cognitive thinking skills and learning performance in abductive inquiries. This experimental design uses control and experimental groups to compare learning outcomes. A control group performed the heat energy experiment in the science laboratory using a "pre-test -> heat energy experiment -> post-test" method, where the participants carried out the learning activities without using „ThinknLearn". The experimental group used the application „ThinknLearn" while performing the same experiment in the science laboratory using a "pre-test -> heat energy experiment + using ThinknLearn -> post-test" method. The learning activities involved pre and post tests around hypothesis formation activities in the context of abductive science inquiry. These tests consist of MCQs and open-ended question which assessed learners‟ knowledge about the topic covered in their science class.

This experiment was a between-subject design. The two ways of generating hypotheses and improving learning are considered as the independent variables; using the application „ThinknLearn‟ versus the traditional approach, while the dependent variable is learning performance in this experiment. The measurement of the learning performance assesses how well each participant has learnt the given science content (i.e. heat transfer energy) while performing abductive science inquiry investigations.

Participants

A total of 161 students from six science classes voluntarily participated in this experiment. They were all NCEA level 1 science students, from Albany Senior High school, Auckland, aged 15-16 years. One of the groups was treated as an experimental group which comprised 86 students from three science classes. The other 75 students were a control group. In the experimental group, 86 students filled in the questionnaire and participated in group discussions while 81 students participated in pre-post activities. In the control group, 75 students were involved in pre-post activities without using „ThinknLearn‟.

For the distribution of the groups (i.e. experimental and control), science teachers were insistent on keeping the class structure intact. Therefore, students could not be randomly assigned to any of the groups. However, three classes apiece were selected as experimental and control groups respectively. In each class, there were previously 8-9 sub-groups for performing their science classroom activities. So, we continued with this distribution and conducted this experiment in the second week of February, 2012.

Apparatus

Both groups were provided with three different coloured tins; *Black*, *Shiny (Silver)*, and *White*. In addition, the experimental group was equipped with WiFi enabled mobile devices. The control group was required to perform the experiment in the traditional way (i.e. without any mobile devices). Both groups had used the same concepts related to the given topic (i.e. heat energy transfer) which were already covered in their earlier classes. For the experimental group, the „ThinknLearn‟ application was used to assist the participants to understand those concepts using their mobile devices. For pre and post activities, a MCQ quiz was provided with the instructions according to each group. Further, a questionnaire was also given to each participant in the experimental group, to investigate their individual learning experiences when using the application.

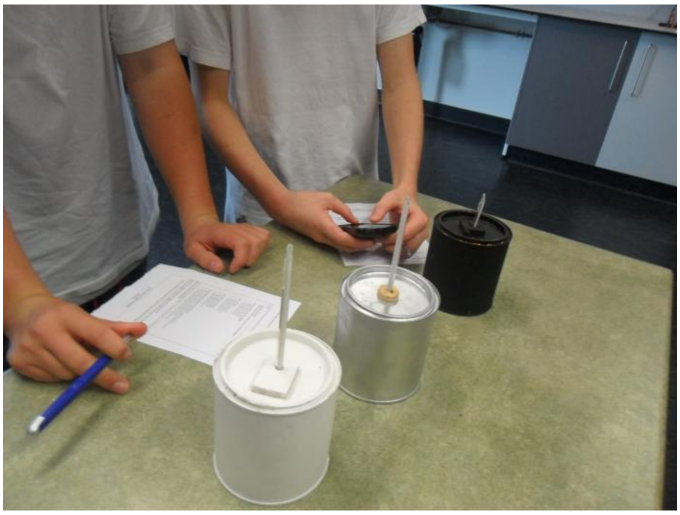

Figure 2 Experimental group participants performing the experiment

Procedure

Initially, science teachers introduced the information about the experiment, the purpose of the study, and the data collection process for each group. Both groups of participants were first asked to answer the pre-test that consisted of four MCQs. Following this, they were required to perform the heat energy transfer experiment as depicted in Figure 2. In this experiment, they found some data values related to each tin. These data values helped them to understand some key concepts discussed in the given topic. At the end of the experiment, they were asked again to answer the same MCQs with the addition of one open-ended question related to the hypothesis, with its explanation. This open-ended question was used to understand how well the participants engaged in the learning and thinking process during the inquiry investigation. For evaluating the usability and the utility of the application, experimental group participants were also required to individually rate a nine-question questionnaire on a five-point Likert scale. They were also involved in semi-structured group discussions. In these discussions, participants were posed three questions which were related to the usability and the softer aspects of the application.

RESULTS AND DISCUSSIONS

Micro Level Evaluation

In this micro level evaluation, the responses from a questionnaire and semi-structured group discussions were gathered from the experimental group participants about their learning experiences while using „ThinknLearn". The control group participants were not involved at this level of the evaluation.

Questionnaire Responses

The questionnaire was filled in by the participants after they had finished their mobile science inquiry learning activities. The 9 questions in the questionnaire attempted to address different aspects of usability (*learnability*, *understandability*, *operability*) and softer aspects (*metaphor*, *interactivity*, *learning content*) as shown in Table 2.The questionnaire used a five-point Likert scale where 1 was „strongly disagree" and 5 was „strongly agree". When this application was tested with science students, their overall responses were encouraging.

No.	Statements	Evaluation Aspects	Mean Response ± S.E (Standard Error)
S1	This mobile learning experience was enjoyable.	Learning Content	3.66 ± 0.11
S2	This mobile application was easy to use.	Learnability	3.66 ± 0.11
S3	Navigation through this application was easy.	Operability	3.87 ± 0.11
S4	This application guides me to formulate a hypothesis.	Understandability	3.45 ± 0.11
S5	The given suggestions in the application were relevant.	Metaphor	3.74 ± 0.10
S6	This application helps me understand the relationships between different variables.	Interactivity	3.50 ± 0.11
S7	The given suggestions help me to understand the topic.	Metaphor	3.54 ± 0.10
S8	This application helps me to improve my reasoning skills.	Interactivity	3.28 ± 0.12
S9	It is an effective learning application.	Learning Content	3.55 ± 0.11

Table 2 Questionnaire statements asked to the experimental group participants

The three questionnaire statements (S2, S3, and S4) were intended to investigate the mobile learning application from a usability perspective. The responses to statements „S2" and „S3" revealed that the participants found this application was not difficult to use and navigation was straightforward. The ratings on the statement „S4" also revealed that our respondents perceived that the guidance towards hypothesis generation and the whole learning process was very easy to understand. A one sample T-test against the neutral value 3.00 confirmed these interpretations ($t_{85} = 6.14$, $p < .01$ for S2; $t_{85} = 7.88$, $p < .01$ for S3; $t_{85} = 4.20$, $p < .01$ for S4).

The responses for the statements about softer aspects of the quality of the application showed positive attitudes from the participants. According to the results, the participants experienced „ThinknLearn" as an interactive learning application ($t_{85} = 4.62$, $p < .01$ for S6; $t_{85} = 2.38$, $p < .01$ for S8). The statements S1 and S9 revealed that our participants considered that this application was an enjoyable learning experience and by and large an effective learning application ($t_{85} = 5.74$, $p < .01$ for S1; $t_{85} = 5.11$, $p < .01$ for S9). Similarly, the responses to the statements (S5, S7) showed that the participants experienced an overall vision of the learning processes ($t_{85} = 7.10$, $p < .01$ for S5; $t_{85} = 5.19$, $p < .01$ for S7). The processes include the relevance of the given suggestions for constructing scientific hypotheses and the assistance provided by these suggestions to comprehend the given topic.

Semi-Structured Group Discussions

The group discussion questions were posed to the participants about their learning experiences as mentioned in Table 3. In these group discussions, 25 groups from three science classes participated.

With respect to question 1 responses, most of the participants considered that „ThinknLearn" was easy to use and they did not find any difficulty while using it. However, there were a few who found this application difficult in terms of its guidance towards hypothesis generation. One of the groups highlighted that "*... questions were difficult and the given suggestions were not easy to understand*". It appears they were unable to relate the suggestions to understanding the given topic. In another instance, one participant of another group described how "*it was not difficult but confusing on some occasions*". Those participants who considered the application a bit confusing may not have understood the deliberate purpose of this application to exploit their higher level skills of critical thinking by posing challenges, but this does not negate the possibility that their understanding was enhanced nonetheless.

As far as the second question is concerned, almost all the participants were positive about their learning experiences and they enjoyed using „ThinknLearn". One of the group participants stated that "*we really enjoyed using it. This application* *was pretty good and engaging, it helped you to learn about your course (science)*". The other group participants gave an interesting comment about it as "*this type of application keeps you on focus and requires better attention*". On the other hand, one group of participants disliked this application. According to them, "*it was boring and confusing and therefore, we did not like it*". Despite this, overall, participants valued the interactivity, enjoyed the innovative way of learning, and found the application engaging.

In the responses for question 3, the respondents believed that the given suggestions were relevant and made them think. One of the group participants indicated that "*these suggestions are relevant to the answers but they make us to think*". On the other hand, there were a few groups who remarked that "*…more detail should be provided*" and "*… relevant but they (suggestions) did not explain much*". These comments showed that this application presents some challenges to the participants and made learners think about the given topic. It may be argued that a certain level of challenge was maintained in this application to make it more engaging and interesting. However, some ways may be needed to convince those participants about the value of this approach. Overall, the group discussion responses suggest that the application was engaging and the given suggestions make learners think about the knowledge space under investigation, and may exploit their cognitive thinking skills.

No.	Group Discussion Questions	Software Quality Measures
1	What type of difficulty do you find in using this application?	Usability aspects
2	How do you feel after using this application?	Softer aspects
3	What do you think about the suggestions given in the application?	Softer aspects

Table 3 Group discussion questions

Meso Level Evaluation

This level was used to examine the learning performance between experimental and control groups. It involved pre and post activities including answering MCQs and writing hypotheses with their explanations while performing science experiments.

Learning Performance

In pre-post tests, participants were asked to answer MCQs related to the learning domain. In comparing these two groups, an independent sample t-Test was used to find out the learning performance differences. The results showed a significant difference (p = .025) between the experimental and control groups. As a matter of fact, the control group participants got marginally better scores in their pre-tests as compared to the experimental group participants. However, in the post-tests, both groups improved but the experimental group gained more in learning performance than the control group, as depicted in Figure 3.

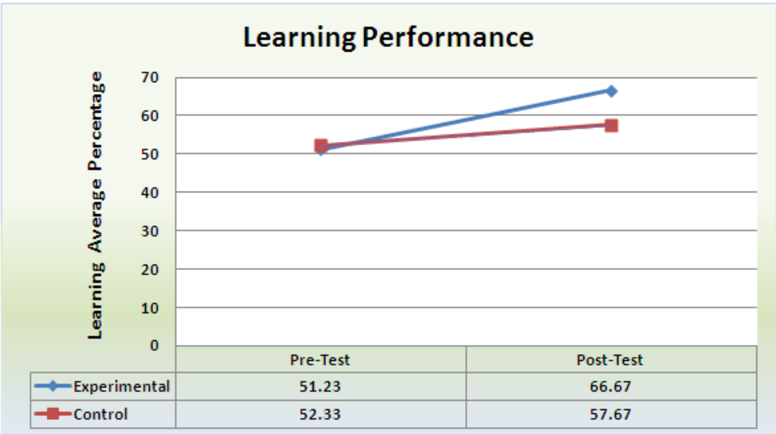

Figure 3 Pre-Post tests comparison between experimental and control groups

In the post-tests, both group"s participants were asked to write a hypothesis about the colour of any of the three tins and its explanation in the open-ended dialog box. As far as the marking of the open-ended question was concerned, it was mutually decided with the science teachers to mark thus: „0" for wrong (or no) hypothesis; „0.5" for a correct hypothesis but a wrong explanation; „1"for a correct hypothesis with its explanation. As an example, one of the answers from the participants who got „1" mark for a correct hypothesis with its explanation was "*Black tin absorbs more heat energy than the other tins and loses more heat energy than the others therefore it keeps the water cool from the inside*". Given that such answers are open to interpretation, and the marking scheme is course grained, there is the potential for bias which should be taken into account when analysing our results.

According to the applied independent sample t-Test, the results showed a significant difference ($p = .017$) between the experimental and control groups. The experimental group participants got improvements in their thinking and learning while formulating hypotheses about the learning domain. However, the control group participants did not appear to understand the given topic so well and therefore were not able to formulate hypotheses and their explanations at the same level as the experimental group. The participants‟ scores in percentages confirming these interpretations as illustrated in Figure 4.

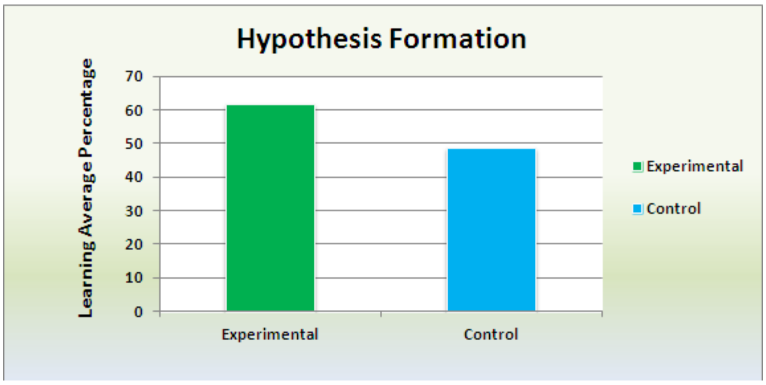

Figure 4 Comparison between experimental and control groups in hypothesis formation activity

CONCLUSION AND FUTURE WORK

The empirical data presented here make a case for the use of „ThinknLearn‟ and provide some insights as to why it might be a more effective way of generating scientific hypotheses than the traditional pedagogy. This innovative application presented a case for the practical implementation of mobile abductive science inquiry applications. It can be suggested that this kind of application may be useful to enhance both learning performance and cognitive thinking skills where learners are engaged in exploring and experimenting in real environments. This can promote deeper understanding of a particular science domain and can guide learners in interpreting data to create meaningful hypotheses.

Although the results discussed above are promising, there are some limitations to this study. It represents a sample from a single science inquiry context which would need to be repeated in similar contexts to validate our results. We cannot state to what extent these results may be generalisable to other technology-assisted science inquiry based learning activities. Further, we had no control over the grouping of the students, and since they performed the experiments in groups, there may be a chance that they worked together in answering MCQs and writing hypotheses with their explanations. In addition, future studies may be required to taken account of other variables not accounted for here, such as learners‟ learning styles, motivation and engagement.

Applications of this kind can be extended further to target other professional fields of interest where researchers or educators want to explore abduction as a form of reasoning such as medical diagnostics, jury deliberation, scientific theory formulation, accidental investigations etc. Moreover, this study may be further developed to support the practical implementation of abduction theory in school sciences, which has not previously been explored.

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iSpot Mobile – A Natural History Participatory Science Application

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ABSTRACT

This paper reports the progress that has been made towards the development of a mobile application to enable people to learn more about natural history by helping them to identify observations of nature as part of the iSpot project (www.ispot.org.uk). The paper identifies relevant research in mobile learning within the field of science and the challenges faced when designing and developing a mobile application for participatory science including the user-centred design approach and evaluation process that were adopted for the development. The paper includes lessons learned when adopting an agile and iterative approach to mobile application development.

Author Keywords
ambient technology; mobile learning; participatory science

INTRODUCTION - MOBILE LEARNING IN SCIENCE

Advances in technology make the current generation of mobile devices more educationally-appropriate through improvements in aggregation and use of services coupled with increasing multimedia capabilities; for example, the powerful combination of picture capture, geo-location and 'network awareness' makes the current generation of smart phone technologies potentially beneficial for rich exploratory and discovery application.

The iSpot Natural History project is one of many such projects which rely on user-generated content and related activities; such activities encourage a transition from consumption of academic content to greater learner collaboration, which are increasingly mobile. There is a wealth of research into mobile learning in science and the prospects of mobile learning to support learning, for example;

Sharples at al. (2007) have characterised mobile learning as 'the processes (both personal and public) of coming to know through exploration and conversation across multiple contexts amongst people and interactive technologies.' p 5. Mobile technologies provide new opportunities for learners to engage with science learning. Informal learning is an important part of this discussion as mobile learning often offers the opportunity of extending learning outside traditional educational settings. Scanlon et al. (2005) describe three factors of mobile learning which outline the ways in which learning is affected, 'First, that learners are on the move, moving around physically but in other ways too, for example between devices and over time. Secondly, a vast amount of learning takes place outside formal learning situations and thirdly the ubiquitous nature of learning' (p4).

New models of inquiry learning have made use of the affordances of mobile technology and these may impact on the experience of the learner (Scanlon et al., 2005). For example, the Personal Inquiry project (Collins et al., 2008; Mulholland et al, in press; Scanlon and Gaved, 2011) investigated scripted inquiry learning and mobile technologies in formal and informal science learning settings. Other theoretical approaches have also been applied to the consideration of mobile learning e.g. self-regulation, as described in Sha et al. (in press). See Vavoula et al. (2005) for a review of mobile learning in formal and informal settings.

Research had indicated that participatory science was a field which suits the development of mobile applications, for example a number of researchers have studied mobile learning in science. Hoppe at al. (2003) had predicted the importance of 'handheld computing devices allow for exploratory activities not bound to a special location, for example field trips, without losing the potential of taking electronic notes and retrieving information of various types.' P256; Chen et al. (2003, 2004) designed mobile learning bird-watching and butterfly-watching systems for supporting learners. Clough (2009) researched a Geo-caching community using social networking tools and community resources to learn about the geology, geography and history of particular areas. Also, researchers have considered the potential of mobile learning for extending access to the outdoors. Davies at al. in the Enabling Remote Access project studied the way in which mobile technology enhanced field learning experiences. Adams et al (2001) describe how 'live' distributed collaboration through field based mobile technology (e.g. smartphones, tablets, laptops) and laboratory static technologies (e.g. multi-touch surfaces, large screen displays, PCs) can support geology learning.

‘Outdoor learning in areas such as natural science has high potential to enhance learning by giving students a real experience of what they shall learn’ Huang,K. et al (2008). The project team therefore decided that iSpot would be a prime candidate for a mobile phone app.

BACKGROUND TO THE PROJECT

In 2007 the Faculty of Science and the Institute of Educational Technology at the Open University set out on an ambitious project to create a service funded by the National Lottery through the Big Lottery Fund which enabled people to learn more about natural history by helping them to identify observations of nature. In 2008 the iSpot site (www.ispot.org.uk) went live. The project has already identified two species previously unrecorded in the UK: a bee-fly (*Systoechus ctenopterus*) and euonymus leaf notcher moth (*Pryeria sinica*). The site is now well-established and very popular with over 18,000 registered users and over 100,000 observations. An iSpot user can post observations of animals and plants on the site and the iSpot community will help to identify them reliably. The service has an ‘expert panel’ that ensure that observations are identified quickly and accurately. The experts are a mixture of amateur and professional naturalists who volunteer their help. The project team at the Open University, led by Jonathan Silvertown (Professor of Ecology), has developed the iSpot community which now includes more than 80 natural history organizations. A sister iSpot site has been created for Southern Africa, whose content and experts are managed by staff at the South African National Biodiversity Institute. iSpot uses a unique reputation system that motivates and rewards learning. Participants gain reputation through correctly identifying observations that have been verified by others. Figure 1 indicates core elements of the iSpot model (the iSpot ecosystem).

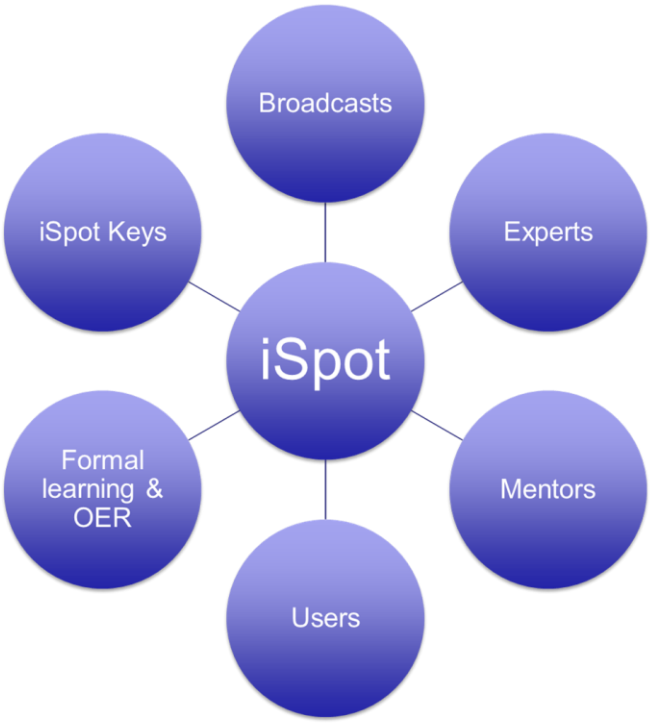

Figure 1- iSpot conceptual model (courtesy Doug Clow iSpot LAK11 presentation - available from slideshare)

The service not only provides information about the observations but also about their geographic locations. It allows people to use geo-tagged images (images with GPS data included in them about their location) or provides people with the ability to add information about where an observation was discovered. The site then uses Google mapping technology to allow people to search and filter using various tags and identifiers to see where observations were discovered throughout the UK.

The website itself is available to be viewed on mobile phones, however because the site focuses on observations, and is more about images rather than text, and because people will naturally be outdoors making observations, there is a need and opportunity to use mobile phones and digital cameras to make observations.

The team took a lightweight contextual design approach to establishing the requirements for the mobile app based on the user-centred design process developed by Hugh Beyer and Karen Holtzblatt (Beyer H et al., 1998), exploring the types of users, the scientific context of nature study, the environment which they would be exploring and the learning outcomes to be achieved. There is a wealth of research pointing to the effectiveness of taking a user-centred approach and the issues facing those designing effective learning environments using current technologies, in particular Bill Buxton says ‘..the nature of software applications is being transformed by virtue of their being embedded into devices that have broken away from the anchor of the stationary PC' Buxton, W. (2007) and Yvonne Rogers describes the challenges of working within these new interfaces in her paper on The Changing Face of Human-Computer Interaction in the Age of Ubiquitous Computing (from HCI and Usability for e-Inclusion (Holzinger, A. et al 2009)). Through this and related research we concluded the main purpose of developing the mobile app would be to allow users to upload observations (a combination of photo, identification, and location) to iSpot using their mobile device. i.e. providing them with a pedagogically grounded instructional design. The secondary purpose would be to enable iSpot website functionality on a mobile device in a native format and using the enhanced capabilities of a multi-touch mobile phone, for example the ability to pinch to zoom on images to see greater detail and the ability to use the devices to interact with the iSpot community whilst on the move and to enhance their experience from that of the website through utilising the geo-location services available within mobile devices.

The app would exchange data securely with the iSpot site, via an appropriate process to manage this handshaking, through the creation of an API within the iSpot Drupal service. The Lead Developer of iSpot, Richard Greenwood, says "Producing a coherent and extensible API was important because it allowed iSpot to be consumed and updated via new channels such as mobile applications and third party websites, this opened up new avenues to reach existing and new users but also offered the ability to start exploring exciting new ways for the website to be utilised, these are the subject of on-going research." The RESTful API includes oAuth authentication layer (www.oauth.net) and uses the HMAC-SHA1 signature method.

The iSpot development team investigated HTML5 rather than native app development but at the time support for HTML5 on mobile was not considered mature enough to allow the team to develop a suitably sophisticated application. Recently PhoneGap (using Apache Cordova) and other similar HTML5 wrapper technologies have made this a much more appealing prospect for app developers, and the long term strategy is to eventually move to HTML5 to avoid the complexities of having to develop bespoke applications for the different platforms.

To reduce complexity the team therefore decided to focus initially on a single mobile platform and the decision was made to develop for Google Android platform for the first iteration of development with a view to porting to other platforms at a later stage. Android was chosen because of (a) Increasing market share - at the time of development sales of Android devices were outstripping sales of any other mobile platform (b) The open nature of the Google technology suite and app store (c) The Open University had an existing partnership with Google over use of the Google Apps for Education to facilitate Open University student interaction. The team were however aware of issues with this platform choice, specifically (a) The number of variants of the operating system that needed to be catered for and (b) The variety of device types and screen sizes. For example Figure 2 shows the current distribution of operating systems and screen sizes over a seven day period ending on 1 August 2012 accessing the Google store.

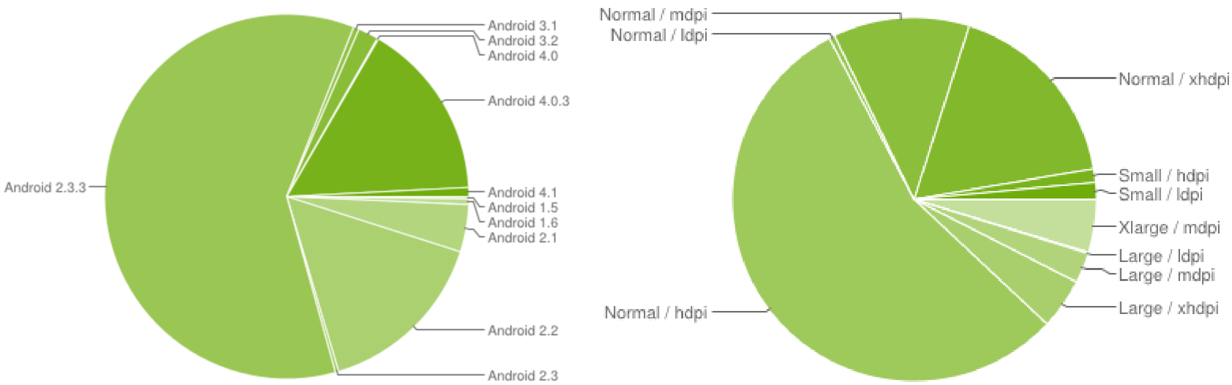

Figure 2 - Data on Android platform versions and screen sizes and densities is based on the number of Android devices that have accessed Google Play within a 7-day period ending on the 1st August 2012 (data and images courtesy of Google).

FIRST ITERATION

As explained previously a light-touch user-centred design approach was used for app development, beginning with a storyboarding process using experiences from users of the current iSpot website, specifically we collected data from a selected group of experienced iSpot website 'volunteer' users then applied interviews and data capture techniques to analyse their practice alongside usage data from the website to establish common patterns of use. We then turned these into stories which became a coherent functional specification. The first iteration of the app started in October 2011 and took eight weeks of development and then a further two weeks were spent bug fixing and adding additional checks. One of the initial issues, as explained previously, was that Android devices have all manner of shapes and sizes of screen and this made the display of the images a challenge. We initially went for a 'clean and corporate' interface design for the app, for example Figure 3 shows a screenshot of the observation list.

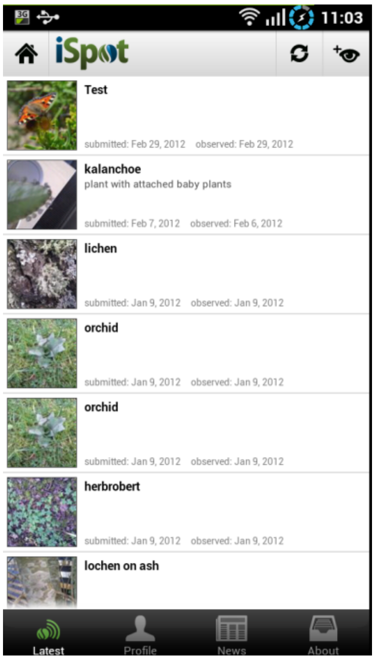

Figure 3 –screenshot of original app design

EVALUATION AND REFLECTION

After the first iteration we began a process of testing the application. A usability expert within IET conducted an expert evaluation. The application was also provided to a group of ten experienced mobile users who were new to iSpot and they were asked to evaluate the app ‘authentically’ using a scenarios gained from the stories we had established earlier in the contextual design process i.e. going out and taking observations in naturalistic settings and then providing feedback on their experience. This was challenging because we were testing both the application and the context of the mobile device stack. We also wanted to identify gaps between what people say they do and what they actually do (Smørdal and Gregory, (2003)), e.g. to validate information gained via follow up interviews.

From the feedback it was clear that people were generally enthusiastic about the functionality of the app but they were less positive about the interface design. For example here is a typical comment we received from one of the testers:-

“She thought she had to put something in the scientific name or the common name and did not realise that she could leave these blank (she knew it was a ladybird but there was not the option to say just ladybird so she selected one of the named ladybirds, a 10 spot one, even though she knew it was wrong just to get to the next screen and submit the observation)”

Desktop research was conducted during this reflection period into the best of breed competitor products in the natural science field, including WildKey and Project NOAH. We concluded that the iSpot app is distinctive from competitors as it references species dictionaries and because observations are identified by the iSpot community, often within a very short time of being observed and uploaded; half of all un-named observations are identified within an hour of appearing on the site.

Through these evaluation processes we realised that we had been creating a service that largely mimicked website navigation and we therefore had to completely redesign the navigation and layout for the mobile app.

SECOND ITERATION

In January 2012, as a result of the user feedback and desktop research, we made the decision to invest in further development and interface design and a further iteration of the application before releasing the beta to the public. We acquired the assistance of a mobile interface designer who worked alongside the developer to implement a set of improvements to the interface. In March 2012 we started a second phase of development.

Our first attempt at improving the interface involved providing a big button menu screen as the ‘home’ to get into the main app functionality (Figure 4). The designer created a stylised logo and incorporated design features of the iSpot website to improve the app and make it feel more nature related by using grass and wildlife within the layout.

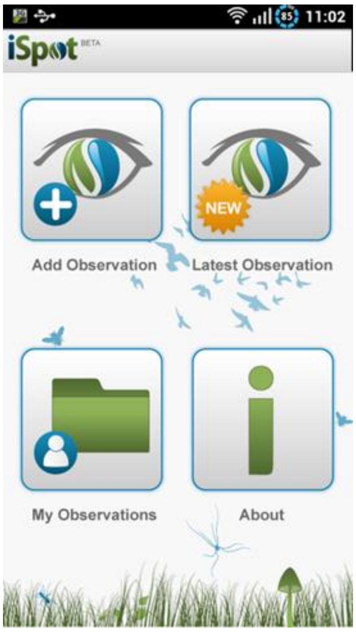

Figure 4 – second iteration theme with more ‘nature’ focused interface design

Testing was again conducted with another group of ten mobile proficient users as part of the development process and this interface received positive feedback from users, however although people liked the design there were still concerns that the navigation was not providing the rich interaction and direct engagement, focusing on the main things the user would like to do and drawing them directly to those. We were also concerned that this interface design was not scalable, i.e. as functions were added how would we incorporate them into the menu?

From data collected through the exercises in the first iteration we were aware that users primarily wanted to see the observations, we therefore decided to explore a design based on taking the users directly to the observations as this emerged as the predominant feature people would most regularly go to iSpot to explore. We made the observation thumbnail images larger to increase usability and aesthetic appeal (Figure 5). We didn’t want to remove valuable screen ‘real estate’ on what is a small screen so we explored using a dynamic menu which users could click on or swipe to view and which provided all the functions within the application allowing extensibility using horizontal swipe to access menu choices.

Figure 5 – the image-centric design adopted for the beta release

The feedback from user testing this with ten participants was very positive about the new interface design, comments included:

Participant 3

“Pull down icon menu intuitive once you try it for the first time”

“Tried taking photo of pot plant and identifying it. Intuitive interface. Easy to add details. Recognised my location. Though somewhat cramped with keyboard. Pleased to see my first observation appear on iSpot.”

Participant 7

“Overall I have found the app to be extremely stable, easy to navigate and fairly intuitive.”

As a consequence of the positive feedback from both user testing and technical testing we felt in a position to move towards releasing the app to the public however we wanted to ensure that we mimicked our standard developmental quality assurance processes as closely as possible so we therefore asked for accessibility testing of the application. This proved challenging since standards are still being established in this area and within the organisation we found that there was no benchmark against which to test the application. We therefore asked our accessibility expert to conduct a review of standards and guidance in this area in order to create a benchmark with which to test future iterations of the application. The results of that research are a list of references provided below (accessed 31st August 2012)

(i) Google Android accessibility guidelines for developers: http://developer.android.com/guide/topics/ui/accessibility/index.html

(ii) Apple iOS accessibility guidelines: http://developer.apple.com/library/ios/#documentation/UserExperience/Conceptual/iPhoneAccessibility/Accessibility_on_iPhone/Accessibility_on_iPhone.html

(iii) Henny Swan from the BBC blog on 'Getting to grips with a mobile accessibility strategy': http://www.iheni.com/getting-to-grips-with-a-mobile-accessibility-strategy/ and lists some 'Resources for Mobile Accessibility Guidelines': http://www.iheni.com/mobile-accessibility-guidelines/

(iv) OneVoice report and 7 principles: http://www.onevoiceict.org/news/moving-together-mobile-apps-inclusion-and-assistance

The evolving benchmark incorporates elements of the WCAG 2.0 (http://www.w3.org/WAI/intro/wcag) website guidelines which also apply for mobile applications; therefore the evolving mobile benchmark follows the guidelines provided by the platform manufacturer (points (i) and (ii) above) where they do not conflict directly with the WCAG 2.0 website guidance. The accessibility testing therefore includes, for example, testing audible feedback using a service such as Talkback (Android) or VoiceOver (iOS).

LESSONS LEARNED AND RECOMMENDATIONS

An important aspect of the project was the creation, at project conception, of a clear vision of how the app will benefit the iSpot user community. This is particularly important when employing contract staff as they can quickly ‘buy-in’ to the concept. The project team had differing ideas of how the app should look and therefore employing the services of a graphic designer early, from the second iteration onwards (Figure 4), was very important as the designer interpreted the different design aspirations and weaved them into a coherent user experience (UX). The choice of Android as the development platform provided some interesting technical challenges due to the many different versions of Android operating system, for example two new versions were released during the development phases, and the complexities of designing for the wide variety of screen layouts. Another lesson learned from the project is to ensure that there are adequate gaps between the different development iterations to allow time for testing and assessment. We allowed a minimum of six weeks between phases. There is a risk that you may lose staff to other projects during the 'gap period' between iterations but the main benefit is that you can improve the quality through comprehensive assessment of the app, interviewing users and gathering feedback to improve the next iteration.

When developing an app consider the following:

(i) Follow an agile approach using short windows of development
(ii) Ensure adequate graphic design input throughout the project
(iii) Establish features and priorities most suitable to app development (e.g. features which appeal to people whilst on the move)
(iv) When appropriate, ensure that there is a suitable, and extensible, API against which to build the app.
(v) Consider designing for a single platform initially and ensure that you consider specific interface issues and standards.

CURRENT AND FUTURE PLANS

The Android iSpot application 'stable beta' was released to the public via the Google Android app store (Google Play) https://play.google.com/store/apps on 8th June 2012. The iSpot app can be accessed on the Google Play store directly by visiting http://goo.gl/BWoM2 .

The iSpot project team are currently working on a third iteration of the mobile application. This iteration incorporates improvements to the application through the feedback gained from the testing processes and through the knowledge of best practice through the feedback from the expert users within the Science Faculty along with enhanced reference material from Google on designing for the Android Platform http://developer.android.com/design/index.html.

Comprehensive testing is currently being conducted prior to release, facilitated by evaluation experts within IET, using the state-of-the-art mobile eye tracking and mobile data capture facilities available within the Open University Jennie Lee Research Labs http://jennielee.open.ac.uk (accessed 31st August 2012). Testing is currently underway and the full product release (version 1.0) of the mobile application is expected later in 2012.

The full release, as a consequence of the testing and evaluation, provides a richer and more interactive experience with an improved user interface, including a contextual "active menu" and larger images, as shown in the sample screenshots below (Figure 6).

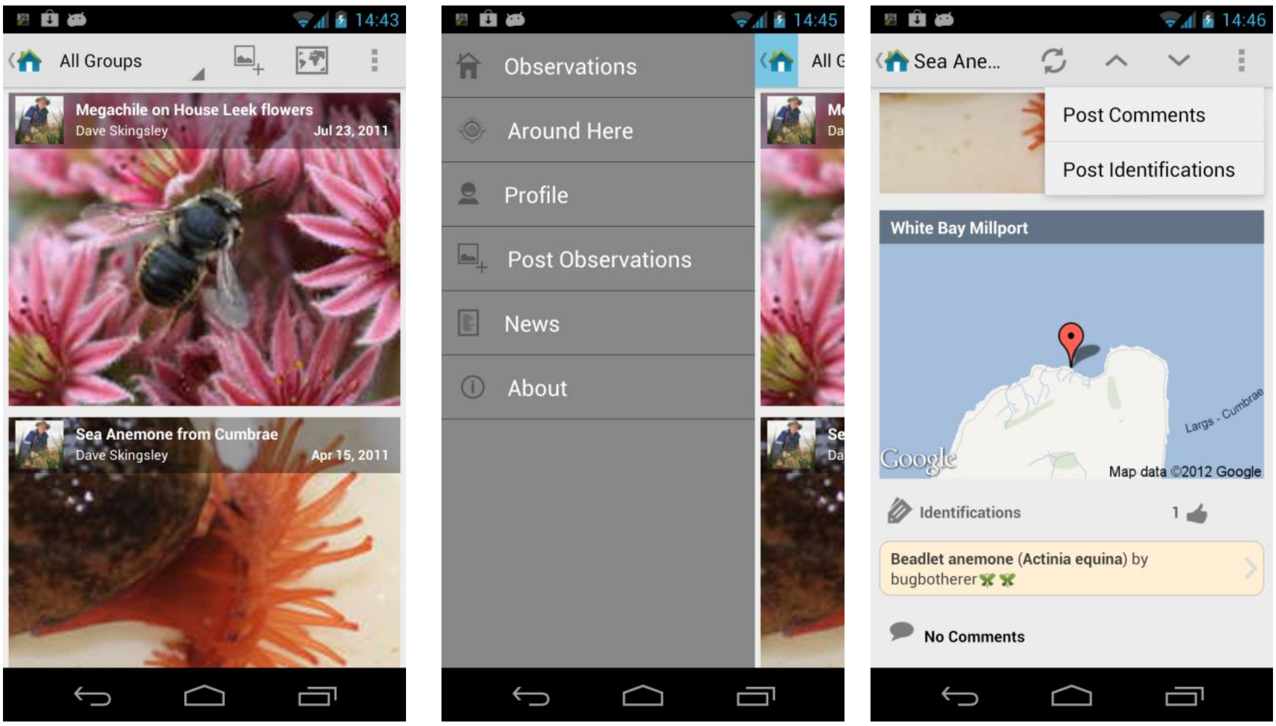

Figure 6 – Sample screens from current development showing (1) "active menu" and text overlays on images (2) the slide out navigation panel (3) The post comment and post ID capability.

There will be enhancements to the geo-location services to provide ‘around here’ information about observations within a specific locale. There will be enhancements to the social and community aspects of the application, in particular allowing users not only to comment on other peoples observations but also to identify them. Finally there will be improvements to the discovery and filtering services to allow users to quickly find out information related to a particular observation and to create their own individual journeys of self-discovery.

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Information Ecologies – A useful approach for observing 'mobile learning in the wild'?

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ABSTRACT
This working paper considers the usefulness of Information Ecologies (Nardi & O'Day, 1999) as a conceptual lens with which to view mobile learning in the wild. The research project was conducted using an ethnographic approach and considers the learning processes and challenges that postgraduates students faced while collecting data during a geographic information systems field trip. Finding a suitable approach from which to examine the issues that arose and audiovisual data created has been challenging. Several approaches have been considered but none allowed the flexibility required. However information ecologies seems to fits this setting's needs and this approach is currently being used for analysis to see what it can elucidate about the setting and processes within it. This paper will briefly outline the challenges faced in selecting a suitable conceptual framework for this novel setting, which observes learning with mobile devices. It summarizes the reasons why both constructivist and cognitive approaches were ill suited to this setting. The concept of information ecologies is explained and its limitations discussed. The paper concludes with a proposed route to harness this approach for this setting, and hence how it might benefit work in this area.

Author Keywords
Mobile learning, field trips, Information Ecologies

INTRODUCTION
This paper contributes to the area of mobile learning research by providing an examination of an underused approach (ecologies) to a setting where mobile learning is becoming increasingly common – learning in the semi-formal educational context of a field trip. A field trip has unique characteristics such as the opportunity for real world contextualization of case based problems and interactions with the natural world. However these also provide challenges for the learners to overcome especially when when interacting with the world via a digital device. It can often be difficult to capture the rich detail of what is being observed with such devices – a problem that both the students and researcher faced during this project. The ecological approach is gaining some popularity in an area where a social constructivist approaches has been fairly dominant please see (Pachler et al., 2010). This work is using the conceptual framework of Information Ecologies, which was developed by Nardi, and O'Day (1999) to deal with the complexities faced by communities who were using new technologies. Their work did not consider mobile technology, which at that time was not ubiquitous; hence this conceptual approach is being extended to this technology. It seems to be a promising lens with which to examine how the various actors, technology and the environment came together in this semi-formal learning setting and how their relationships were shaped. This could be a valuable way how communities integrate mobile technologies and use it to inform design for learning. Initially the characteristics of mobile learning on field trips are considered before examining information ecologies in more depth and how it will be applied.

MOBILE LEARNING ON FIELD TRIPS
The field trip setting displays unique characteristics – making it a novel setting in comparison a more formal academic setting. Most often field trips are conducted in real world settings and interact with the local environment. These educational contexts are short lived, artificial and intensely social events. The students often look forward to taking part in field trips as they enjoy the new setting, social aspects and different style of learning and teaching that are inherent in this context. Field trips can be a day out or they can be residential – those observed during this project where the latter. In this situation students and staff are required to cohabit (to varying degrees depending upon the logistics) and this produces interesting social dynamics. While this research was privilege to this, the focus was upon the learning journeys taken by the students during the projects set on the field trip. Several problems within a case based approach were posed and the students worked in groups to conduct their own research project to examine these problems. Mobile devices were an implicit part of these projects hence the focus was upon the roles the devices played, how the students interacted with them and around them during the course of their project. A theoretical approach was needed to frame these observations in their social context and examine the learning processes. However field trips are real world, albeit artificially contrived, intense but short lived, physically as well as mentally challenging, semi-informal in their educational format, dynamic and mobile across contexts both socially and educationally. In short they are not often an easy fit to many approaches and not comparable to other educational situations.

The project's educational setting consisted of residential postgraduate field trips in geographic information systems (GIS). This research project was an ESRC funded studentship linked to the Teaching and Learning Research Programme (http://www.tlrp.org/) Technology Enhanced Learning projects (http://www.tel.ac.uk/). The aim was to observe how the learning processes were influenced by the use of mobile technology on field trips. The students completed case-based projects in the field where they had to design and conduct mini project mobile devices to collect their field data. The mobile devices were specialist GPS enabled GIS devices which are essential for collecting data on the field trips. As the students were mostly inexperienced in using this technology the field trip was an opportunity to experience data collection in a real world context to discover the inherent issues in this activity and how these can influence the later data analysis in the context of their research mini project. However many smartphones are now capable of collecting this type of data. This became apparent in the final field trip in 2010 where the balance seemed to be shifting towards preferring personal devices however this is further discussed elsewhere (Beddall-Hill, 2011). The students were faced with the task of learning to use different devices but also at times incorporated their own personal mobile technology. It was interesting to observe how the students negotiated the challenges in operating and using these devices in a field setting where they did not always have direct access to staff for support. The difficulty of framing field trip settings has frequently been debated due to their contradictions. In this setting the role technology played was extremely important and hence an approach was needed which reflected this.

ECOLOGIES AND INFORMATION ECOLOGIES

While the ecological paradigm originates from within the biological sciences it must be applied extensively to other settings where fluid interrelationships are the focus. Applications of the ecological perspective include cultural ecology, semiotic ecology and Gibson's (1979) ecological approach to perception. These take a macro viewpoint of the world and how we interact with it. Although the ecological paradigm has also been used to observe micro systems in particular institutional settings and also the effects of technology upon our social worlds (Brown, 2000). Both Brown (2000) and Frielick (2004) propose using an ecological perspective to view learning within the technological age. Freilick's (2004:328) key idea is that "teaching/learning is an ecosystemic process of transforming information into knowledge, in which teacher, subject and student relationships are embedded or situated in a context where complex interacting influences shape the quality of learning outcomes". Freilick (2004) suggests we need to 'de-learn' in this new setting and Brown (2000) suggests we need new skills such as digital navigation and bricolage to build what is needed from digital media. These adaptations are less useful to this research setting as they are highly contextualised within a virtual environment (e-learning online) and not real world.

Nardi and O'Day (1999:49) use ecologies as a metaphor to observe the interactions of people and technologies in local setting. They define Information Ecology as "a system of people, practices, values, and technologies in a particular local environment". They developed this approach from ethnographic observations mainly conducted within Silicon Valley in this era. Information ecologies enjoyed some fame within knowledge management Davenport & Prusak, 1997) computer science (Nardi & O'Day, 1999) and library science in the late nineties. At this time it was a useful term for these areas to try to understand the changes that technology was bringing to work places through the use of metaphors while still privileging the people involved.

The key aspects of ecologies according to Nardi and O'Day (1999) are as follows:

An ecology responds to local environmental changes and local interventions. An ecology is a place that is scaled to individuals. We can all name the ecologies we belong to and participate in. In an ecology, we are not cogs in a sweeping sociological process. Instead, we are individuals with real relationships to other individuals. The scale of an ecology allows us to find individual points of leverage, ways into the system, and avenues for intervention. (p. 50)

Nardi and O'Day (1999) focus upon the human practices that are served by technology, proposing that microenvironments such as hospitals and libraries are information ecologies. In these settings people, technology and other artifacts come together in congenial relationships that are driven by the values that are present in that ecology. Both the people and the context supply the values – in a hospital it would be providing care while in a library an information service. Ecologies are used in a metaphorical sense to represent complex diversity where many relationships are taking place and most importantly they are continually evolving. They are a system which fit together. Within a hospital this could be the different roles that doctors, nurses and administrators play to provide care. There is also an urgency portrayed by ecologies because there is the possibility of failure due to environmental issues (Nardi & O'Day,1999). However breakdown or failure need not be the end of ecology. In nature ecologies are constantly renewing and rebuilding themselves once they have evolved to cope with the new demands placed upon them. For Nardi and O'Day ecologies provide a set of concepts with which to view a setting but most importantly they urge the members of that ecology to use the knowledge these provide to directly participate in developing that ecology to help it grow and thrive.

Limitations of the information ecologies approach

Using an ecological approach outside biological science raises some interesting questions – such as whether we can look at the social world in a similar systemic way to the biological one that was founded upon empirical research. Essentially we are retrofitting these concepts to a setting where we are using fundamentally different types of research designs and collecting different types of data. It could be argued that because we are using these concepts in a metaphorical way the conflicts are reduced. Nevertheless using a cyclic approach can be difficult to enter as where does it start? It is unlikely to contain only one cycle but instead have a network of different niches with different interrelationships. When specifically considering the information ecologies approach Fedorowicz et al. (2004) suggests we consider time frames and the nature of human choices and interventions. When applying natural science theories to social science settings time frames are dramatically different. Within biological systems time is considered over decades whereas within this setting we are considering only a week. Fedorowicz et al. (2004) state that it is necessary to give time frame and clearly explain the methodologies used and data collected to allow others to form their own opinions around the nature of the changes that were observed. Furthermore individuals influence the settings through active decisions and by exercising our values – this does not occur in the same way within nature's ecologies. From an methodological standpoint ecologies reflect a systems approach that could be considered reductionist and might not elucidate the contradictions that ethnographies can reveal. However Nardi and O'Day (1999) use the systems approach as a framing and provide a reflective account of their observations where contradictions can be highlighted when necessary.

The use of the ecological approach has been more limited in education in comparison to the social cognitive and constructivist approaches. Furthermore the application of information ecologies has been inactive since the early 2000's. All societies and hence ecologies develop at different rates so care is needed as this framework was developed in within a different time and place to the field trip setting therefore parts of it may not be a good fit. The concept arose from ethnographies within Silicon Valley in the nineties so it could be considered technologically dated. Yet it was developed because Nardi and O'Day (1999) were concerned with the "Anytime, Anywhere" phase, which even at that time was the mantra of Silicon Valley and its workers (1999:209). They questioned whether we want to place such a demand upon ourselves. Do we need to be more efficient at everything, all the time? In thinking along these lines they encourage individuals to question their ecologies. They suggest asking 'know-why' as well as 'know-how' questions. This is particularly relevant to this setting where mobile technologies are becoming ubiquitous – why and what are the implications of this technology, not just what are the best ways to use it. Nardi and O'Day did not consider mobile technologies so this would be an interesting opportunity to apply an approach built to explore and empower those undergoing a huge technological change (the world wide web and personal computers) to a similarly momentous development – mobile technology.

INFORMATION ECOLOGIES AND MOBILE LEARNING ON FIELD TRIPS

The field trip could be considered an information ecology as it is filled with social interaction, technology and shared values (a system of interrelationships that affect each other). A diverse group of individuals are involved who bring different experiences and motivations. They might inhabit niches of the area or be relatively new to the wider ecology of the discipline. The values focus on experiential learning and achievement of the necessary requirements for successful assessment. Equally it could be argued that the members of a field trip group try to enable an enjoyable experience for themselves and others. It occurs in a set locality which is dependant upon the destination and an ecology grows specifically to meet the needs of that setting and group. The individuals adapt or evolve their practices to fit the setting for the short time they spend as a collaborative working social group. Technologies are present but at the forefront are the educational experiences and learning processes of the students – who are given freedom in how they use the technology. This allows them to experiment and shape their group practices as needed to respond to the environmental (how the data is collected) and educational challenges (what data is needed to resolve the research problem they were posed).

Importance should be placed upon the relationships between people, practices and tools not just the technology present as the driving force within the setting. Nardi and O'Day (1999) encourage researchers to look beyond the formal accounts of the practices within the settings, instead concentrating on the informal impromptu practices that take place. These may be processes that are not made explicit but contribute to the success of the activity. Within field trips this could be the social interaction and individual experiences that each group member brings to the problems they face. These kinds of practices are often not elucidated within research observing fieldwork with technology. How these impromptu and discovery practices shape the use of the technology and demonstrate how mobile fieldwork ecologies continue to develop and advance during their short thriving periods. Having knowledge of these could enable a practitioner to discover new avenues of intervention and produce options for designing with technology.

Applying information ecologies to mobile learning on field trips

Questioning of technologies before they enter the field trip ecologies could reduce problems such as learning lag and using technologically dated equipment or software. Nardi and O'Day (1999) suggest using a strategic questioning framework to identify different families of questions to led discussions of information ecologies. They believe these questions can be adapted to any information ecology; this questioning is intended to extend the analysis of this mobile learning field trip. Initially a rich picture analysis was used to map out the ecologies then thematic analysis is being used to identify the key themes present in this setting. Yet questions about the ecologies could enable deeper analysis of the processes, which are behind these themes.

Firstly there are questions that describe the issue; these will help address the first research question of what is going on in this setting. They consider the motivations and opinions within the setting (analysis) so what is the goal of using mobile technology on field trips. What can be seen (observation), how the students are using the mobile technology. The key facts (focus) what mobile technology is being used and when. Finally feelings questions such as how the students felt about the mobile technology used in these ecologies. The second set of questions dig deeper and are useful for investigating practices to suggest change. The researcher was an observer and not a key member of the ecologies within the field trips, these questions are to be approached but from the researcher's perspective instead of a member of the ecology. These questions include – what might we alter to enhance the use of mobile technology on field trips (change), what if the students used their own mobile devices (alternatives), what might the consequences be if we let students use their own technology (consequences), what could hinder this approach (obstacles)?

Previous work has concentrated upon how we use mobile technologies in such settings (Priestnall et al., 2009, Stott, 2007) but has not questioned when and why it is most appropriate for use. A further consideration is whether we use one technology or device over another, in the case of field trips and increasingly within education generally this is the use of personal devices over institutionally provided devices. By thoroughly questioning the use of the mobile technologies present in this setting hopefully some insight will be provided for educators who engage in similar ecologies when considering how they might better shape them. It also begs the question of how much control we have over personal technologies entering our ecologies due to their inherent mobility, hence how they might be best used and managed is perhaps essential to consider. An ecology is unique and hence while the results of this work hope to provide a case of this in use with mobile technologies, it will only be useful as guidance as it is limited to this setting and one outsider's perspective. Nardi and O'Day (1999) state, that no single member can have enough knowledge of the information ecology to ask the right questions or give the depth for answers required, every member's point of view is valid and could aid the development of the ecology to meet the values of that group. The questions posed in this working paper are intended for development as the analysis progresses and this study will not attempt to answer all types of questions that Nardi and O'Day (1999) suggest. Instead it is more interested in using Information ecologies to aid a metaphorical description of the complex web of people, tools and practices observed within this novel setting.

CONCLUSIONS

The use of ecological frameworks is fairly common within academia (Frielick, 2004) and more recently beginning to gain favour within mobile learning contexts (Pachler et al., 2010). Information ecologies compared to the other approaches considered retains an open approach to viewing the setting, looking at the system of individuals and technologies while placing emphasis on the individuals and not the technology. It encourages a way of viewing the setting, which would enable direct participation for change thereby empowering the users. Despite being dated this approach could be extended to the use of mobile technology. It may be further utilised in the uncovering of informal practices occurring on field trips around mobile technology and how this information could be used to consider the bigger questions of why it should be used not just how it should be used.

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The CLAS App
A mobile training tool to improve handover procedures between hospital interface and family doctors

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ABSTRACT
There is a high potential for mobile learning and support applications in the health domain. In this paper we introduce the CLAS App, a mobile application to support handover procedures based on the improvement of writing skills. Handover of patient care is a time of particular risk and it is important that accurate, reliable and relevant information is clearly communicated between one caregiver to another. Improperly conducted handovers lead to wrong treatment, delays in medical diagnosis, life threatening adverse events, patient complaints, medical litigation, increased health care expenditure, increased hospital length of stay and a range of other effects that impact on the health system. The CLAS App helps standardise and improve handover communication between hospital and community healthcare.

Author Keywords
Mobile learning, health, patient safety, handover, standardization, human error, quality assurance, communication skills, writing skills.

INTRODUCTION
Handover of patient care is a time of particular risk and it is important that accurate, reliable and relevant information is clearly communicated between one caregiver to another. Improperly conducted handovers lead to wrong treatment, delays in medical diagnosis, life threatening adverse events, patient complaints, medical litigation, increased health care expenditure, increased hospital length of stay and a range of other effects that impact on the health system. The World Health Organization (WHO) lists accurate handovers as one of its High 5 Patient Safety initiatives (Joint Commission on Accreditation of Healthcare Organizations, 2011). Training of handover skills would appear to be a promising approach to improve the quality of patient handover. However, the lack of handover training in undergraduate medical education and the need to address this deficiency has been succinctly elucidated (Gordon & Findley, 2011). Research has identified dissatisfaction amongst junior medical staff with current practices as a result of a lack of policies and appropriate training (Gordon, 2010). Moreover, in Europe, training in handover and patient safety is disjointed, lacks focus and there has been a failure to carry out sufficient research assessing appropriate educational strategies (Gordon & Findley, 2011; Reisenberg, Jaeger, Padmore, 2009; Johnson & Barach, 2009; Jeffcott et al., 2009).

Written communication is an intrinsic part of handover. Patients rely on the hospital discharge letter to communicate their 'story' as an in-patient to their family doctor. Their doctor relies on this letter to provide him with the information that he needs to take over the care of the patient. Yet, there is a lack of educational tools to help doctors improve written communications with their colleagues and their patients. To address this problem, the School of Medicine at University College Cork developed a 50-item rating scale (**C**ork **L**etter-Writing **A**ssessment **S**cale - CLAS) to help medical students and doctors improve the quality of hospital discharge letters and thus improve information transfer at handover. Students can use the scale as an assessment tool to evaluate the quality of hospital discharge letters and as a reference checklist when writing discharge letters. The CLAS scale has been developed as a mobile application to support medical professionals at point of practice during the handover procedure.

In this article, we describe the CLAS handover mobile application (CLAS App) designed to standardise and improve handover communication between hospital and the community. The mobile application is designed as a digital checklist. In the next section (section 2), we introduce the added value of mobile applications for the health domain in general. In section 3, we present the rationale behind the Cork Letter-Writing Assessment Scale (CLAS) and present the conceptual checklist. In section, 4 we show the implementation of the CLAS checklist as a mobile application. Finally, we conclude with a summary of the main findings of our prototype study and future research opportunities and plans.

ADDED VALUE OF MOBILE APPLICATIONS FOR THE HEALTH DOMAIN

Recent technological advances in a rapidly changing world have led to a seachange in how we communicate and interact. Social networking and mobile devices are powerful new platforms for 21st century communication. Generation Y has embraced this technological age with enthusiasm. The medical profession has been quick to become part of this process. Doctors constantly strive to stay informed about new research and developments. Technology has made possible the rapid storage, retrieval and synthesis of information. Medical students and doctors increasingly use mobile devices to access everything from drug formularies to medical applications. Pocket textbooks and drug formularies have been replaced by mobile devices. The days of white coats bulging with textbooks and scraps of paper are a thing of the past. In a recent study at the University of Maastricht, selections of apps have been defined and evaluated in the practical worklife of medical advanced students (Donkers et al., 2011). The sets of applications evaluated have been defined based on a list of criteria and functionality that has been elicited from a context analysis. The functions identified include: a) doing specific calculations b) reference books for dedicated information c) evidence based medical information access d) case related information e) in-situ practices, e) personal learning environments.

In general, mobile applications can be powerful vehicle for the provision of information, checklists, formularies, clinical tools and assessment. They are, in effect, the doctor’s little helper, always on hand, always constant, flexible, supportive, accessible and instant. They provide the information when it’s wanted and where it’s wanted, with speed and ease of access. Medical students have embraced mobile phones as a learning platform and they welcome mobile applications in medical education with enthusiasm. We do not have to persuade or convert medical students to this form of Technology-Enhanced Learning but rather, the students themselves are leading how medical education needs to be delivered, especially point of practice resources. In addition, mobile applications have the facility of being enabled to talk to each other, and can transfer information quickly and seamlessly. Besides the seamless access to information and computational assistance, mobile devices also can be seen as always present notification systems. New approaches in the area of context-aware computing also take specific context changes or triggers to notify relevant stakeholders and users of these changes and trigger consequent action. A comparable technique is also applied when using mobile devices to collect data in the field with methods as experience sampling which often plays an important role in field studies (Larson, 1983).

Beside the classical function of learning support, information access, and notification, mobile applications have particular promise at handover, when information transfer needs to be accurate, fast, and complete. The combination of mobile information for understanding and following defined procedures, the delivery of training and reflection tasks on site, and also the triggering of contextualized notifcation gives a unique opportunity to increase training and quality of handover procedures.

Related projects

The development of the CLAS App benefits from two related projects that also address communication issues within medicine, the FP7 HANDOVER and the EMuRgency projects. In the following sections, we will introduce the two projects and outline their main contributions to the CLAS App.

The Handover project

The first research project on handovers, the FP7 HANDOVER (FP7-HEALTH-F2-2008-223409) project, acknowledges that training and learning are important means to encourage the implementation of accurate handover models and tools. It describes the training needs and therefore offers new and innovative learning and teaching tools such as the HANDOVER Toolbox and its content, to change that situation (Johnson & Barach, 2009).

The HANDOVER Toolbox is a learning network (Drachsler, 2009) that acts like an online community of practice (Wenger, McDermott, Snyder, 2002) for medical professionals and especially young doctors and their trainers (see: www.handovertoolbox.eu). This environment takes into account the diversity of solutions available and contains (a) information on standardized tools and ready to use tools to improve handover, (b) information on what needs to be taught and how to train handovers including ready to use training material, and (c) guidelines on how to take into account cultural and organizational issues when improving handovers. The Handover toolbox is available for all stakeholders who want to improve handover practices in their organization. It provides practical guidelines in the form of quality indicators that can be applied for decisions on the content of training, for selecting the most appropriate training design and for establishing favourable learning environments and tools that increase the effectiveness of the training.

However, this is only the first step in the design and delivery of training in handover. The final implementation phase in Europe’s medical systems has only partly been achieved within the project. Further efforts and support is needed to implement the developed solutions into the medical education systems. We believe that the CLAS App can be a facilitator that can be used in handover training, connect to the provided contents and the community available in the handover toolbox. It therefore provides a supportive contribution to the current state-of-the-art training in handovers.

The Emurgency project

The EMuRgency project (EMR INT4 1.2.-2011-04/070) is a socio-technological innovation project to increase the rate of first-responder Cardio-Pulmonary Resuscitation (CPR) in the Euregio Meuse-Rhine. The project combines several technological and educational innovations to reach this goal. Besides a notification system for first responders, the project develops educational support and training apps to help volunteers and medical staff in the memorization of facts, activities and procedures to follow when conducting CPR. In this way, the project is also focused on improving citizen/patient safety through the use of mobile devices. Studies have shown the retention times of CPR training decrease after approximately 6 months. Through a combination of preparatory E-Learning, traditional courses in schools and mobile apps, we aim to offer flexible educational opportunities for people in the region and to increase retention times without formal training. In this sense, the EMuRgency project aims to both support performance and to assist preparatory learning, information transfer, and retention of learning knowledge and skills.

The contribution of the CLAS project

The CLAS project combines research aspects from both projects on a new topic. CLAS also tries to improve handover procedures through educational tools and standards like the FP7 Handover project. More specifically, CLAS aims to improve writing skills for discharge letters that are an important means for handover communication between hospital and community doctors. In contrast to the handover projects, it does not try to teach medical standards in any group settings but provides the target user with a mobile application to memorize and check the required aspects of a discharge letter with a mobile device. This approach is in line with the objectives of the EMuRgency project that follows a comparable approach using mobile learning opportunities to develop and sustain procedural knowledge for CPR training.

RATIONALE FOR THE CORK LETTER-WRITING ASSESSMENT SCALE - CLAS

Communication, in particular written communication, is integral to handover and the hospital discharge letter is probably the most important of written communications between hospital and family doctors. Healthcare professionals taking over patient care need to know the patient's story: what the problem was, how was it diagnosed and what was done about it (Alpers 2001; Goldman, Pantilat, Whitcomb, 2001; Poon et al., 2004; Coleman & Berenson, 2004). Medication, problem list, management plan and follow-up are particularly important. Incomplete or inaccurate information at handover can contribute to faulty medical decision-making or lack of adequate patient monitoring during follow-up (van Walraven et al., 2004).

Quality of hospital discharge letters for handovers

The quality of hospital discharge letters is variable (Kripalani et al., 2007). Most discharge letters are written by junior doctors as part of their many daily duties. Often a handwritten summary is given to the patient on the day of discharge and a typed full report follows at a later date. Computer-generated letters are increasingly available but may lack flexibility and may not include all important items. Discharge letters frequently omit, or fail to emphasize, important information. Letter format may lack structure, clarity, and 'readability'. Legibility is a big concern in hand-written letters. Often the GP receives the discharge letter at night-time or on weekends, times when the full hospital team is not on duty and clarification of confusing content is difficult. Moore et al. (2003) found that handover errors occurred in around 50% of patients and were associated with a significantly higher risk of readmission. A recent review (Kripalani et al., 2007) found that primary care physicians generally rated the following information as most important for adequate follow-up care: main diagnosis, pertinent physical findings, results of procedures and laboratory tests, discharge medications with reasons for any changes to the previous medication regimen, details of follow-up arrangements made, information given to the patient and family, test results pending at discharge, and specific follow-up needs. However, audits of hospital discharge letters show that these details, along with other administrative and medical information, are frequently missing (Kripalani et al., 2007). Discharge summaries often did not identify the responsible hospital doctor (missing from 25%), the main diagnosis (17.5%), physical findings (10.5%), diagnostic test results (38%), discharge medications (21%), treatment or hospital course (7%-22%), and follow-up plans (14%) (Kripalani et al., 2007). The highest rates of missing information related to tests pending at discharge (65%) and counselling (information) provided to patients or families (91%) (Kripalani et al., 2007). Physicians estimated that patient care was affected adversely in about 24% of cases by delayed or incomplete discharge communications (Harding, 1987). One study found that 41% of patients had test results pending on the day of discharge, and nearly 10% of these results were rated as potentially actionable, some requiring urgent attention (Roy et al., 2005).

The importance of medical checklists and the CLAS approach

Use of standardized formats has been shown to improve the quality of procedures within health and especially for interface procedures such as hospital discharge letters. Van Walraven et al. (1998) found that a standardized format with clear subheadings was better than narrative summaries (shorter, easier to access most relevant information) Rao et al. (2005) found that a standardized template for discharge dictations improved the quality and efficiency of dictations. The recently published WHO 'Patient Safety Curriculum Guide' advocates the use of checklists in medical training (WHO Patient Safety Curriculum Guide October 2011):

'Checklists, protocols and care plans designed for particular categories of patients are effective ways of communicating patient-care orders.'

*'In many cases of avoidable maternal death identified in the UK Confidential Enquiry, care was hampered by a lack of cross-disciplinary or cross-agency cooperation and communication problems, including poor or nonexistent cooperation between team members, inappropriate or inadequate telephone consultations**, failure to share relevant information between health professionals, including between GPs** and the maternity team, and poor interpersonal skills.'* (WHO Patient Safety Curriculum Guide, 2011)

Within the CLAS project, we developed the CLAS scale that aims to support students/junior doctors to reflect on their writing and the handover procedure. CLAS is an itemised checklist developed to help write accurate and clear patient discharge letters for handover procedures. This checklist includes key elements of the GP discharge letter as detailed in Table 1. The items are arranged in specific sections listed in the order in which they should ideally appear in the letter.

Table 1. Cork Letter-Writing Assessment Scale (CLAS)

General	• Personal patient data / GP's name • MRN • Hospital • Ward • Consultant • Speciality • Date of admission / discharge	General details include basic demographic details such as name, address, date of birth, Medical Record Number (MRN), date of admission and date of discharge of patient. Other items include name of hospital, name of ward, name of consultant and speciality. A specific rating exists for identifying the name of the GP (General Practitioner of Family Doctor) i.e. 'Dear Dr Casey' rather than 'Dear Dr'.
Problem List	• Is there a problem list?	A bulleted list of the patient's problems provides an immediate soundbyte of the patient's overall status. Ideally, the problem list should be at the beginning of the letter and highlighted in bold typeface.
History	• Reason for admission (presenting complaint) • History of presenting complaint (details) and other relevant history • Past history	This section includes reason for admission (presenting complaint), history of presenting complaint (details) and other relevant history. Past medical history is included here. Current medication at time of admission can be listed here.
Physical examination	• Pertinent clinical findings appropriate to the case	Only pertinent clinical findings appropriate to the case need mention.
Investigations	• Investigations done • Results of abnormal investigations • Test results pending	List of investigations and abnormal results. It is important to mention test results that weren't available at time of discharge.
Diagnosis/diagnoses	• List of diagnoses • Identification and highlighting of new diagnosis	List of diagnoses and highlighting of new diagnosis.
Treatment	• Treatment/hospital course/ complications	A brief summary of treatment given to patient, course of illness while in hospital, and details of any complications that occurred.
Current status	• Current status documented?	The patient's family doctor needs to know the patient's current state of health and mobility. Is the patient well and ambulant on discharge or does he need help?
Management Plan	• Management plan listed? (score 2)	The management plan is a key section and should clearly outline what further investigations/treatment are planned for the patient.
Medication	• List discharge medication? (score 4) • Dose written correctly? (score 2) • Any medication stopped and why? (score 2) • Any new medication commenced and why? (score 2)	Medication error is a major source of potential medical error and has been given higher scoring on the CLAS scale to reflect this. All medications should be listed clearly and written in formal units. In addition, special mention should be made of medication that has been discontinued in hospital and the reasons for this. New drugs commenced should be highlighted and whether they are to be continued as a regular medication or to be prescribed for a limited period only.
Follow-up	• Follow-up (Outpatients Department (OPD) appointments listed)? • Details of other appointments and referrals e.g., chiropody and who has to make the appointment (hospital or GP) • Need for specific blood tests - when and who (GP or hospital)?	This section informs the GP if the patient is returning to the hospital Outpatients Department for review and when. Often a patient may have multiple follow-up appointments in different departments i.e., ophthalmic review, pulmonary function tests appointment, diabetic clinic appointment etc. Details of these appointments should be given and it should be made clear who has to make the appointment (hospital or family doctor). If a patient needs regular blood tests (e.g., for regulation of warfarin therapy), details of how often these need to be done and where (family practice or hospital) should be clarified.
Communication of information to patient	• Information shared • What was explained and to whom? (patient or relatives).	It is important that the patient's family doctor knows how much information was given to the patient (or the patient's family) about diagnosis, treatment and prognosis (especially in the case of terminally ill patients).
Sign-Off	• Name of letter-writer • Title of letter-writer • Bleep no. or phone no.	Letters should end with the name, title (intern, registrar etc.), bleep number and contact details of the letter-writer.
Clarity and writing style	• Letter appropriate length for the diagnosis? • Structure - did the letter flow logically? • Will reader understand all the abbreviations? • Is the writing legible? • Is there good use of headings? • Readability - easy to read, good syntax, grammar, spelling	Finally, the CLAS scale has a 7-point checklist to help improve overall writing style, clarity and 'readability'.

THE CLAS APP

Within the CLAS scale checklist, items are grouped in the various sections e.g., History, Physical examination. Touching the section check-box signifies completion of that group of items; touching an individual item signifies completion of that particular item. Items not 'ticked' appear at the end as a separate list of 'unchecked items'. The CLAS App therefore functions as a quick checklist to be used at point of practice. The CLAS application also generates a total score before inviting the user to view his unchecked items.

All items score 1 point except for the five more important criteria for accurate handover procedures: 1. Management plan (2 points), 2. List of discharge medication (4 points), 3. Drug doses written in formal units and clearly written (2 points), 4. Names of any medication stopped and why (2 points), and 5. Names of any new medication commenced and why (2 points). These criteria reflect the particular importance of accurate transfer of medication information for the handover process. The point of the scoring system is to promote the quest for the 'perfect score' of 50. A letter scoring 40 may still be good discharge letter, but the objective is to attempt to write the 'best possible' discharge letter. Students also appreciate being able to increase their score as they become more familiar with the scale and positive feedback encourages good practice.

Another important use of the scoring system is that the CLAS App can be used to grade the quality of discharge letters in research projects. In addition, the integration of a scoring system into the app allows quantification of improvement in letter-writing when the CLAS scale is taught to medical students (CLAS intervention study).

No patient data are entered at any point, thus there are no ethical or medico-legal issues regarding the storage of personal or clinical data.

By using the CLAS scale frequently, and by being prompted that certain items have been omitted, students and doctors can increase their recall of important items, thus improving the quality of hospital discharge letters and optimizing handover practices. By increasing awareness of the importance of discharge letter content and quality, doctors and medical students may pay more attention to this important area of handover.

In addition to letters to family doctors, the CLAS application can be used to improve the quality of all referral letters (i.e. letters to other consultants, letters to physiotherapy etc) and can serve as a model of good written communication between care-givers.

The CLAS App display screen was designed to be simple, intuitive, and user-friendly. Figs 1 - 4 demonstrate the interaction flow within the app. The information icon is displayed on the top left of the screen, to avoid accidentally checking it while checking the section tick-box. The information page explains how to use the App and can be accessed at any stage in the process. The colours of the items fade when an item is checked, rather than changing in colour, as we found this design more visually acceptable to our pilot test users and more aesthetic as a screen display.

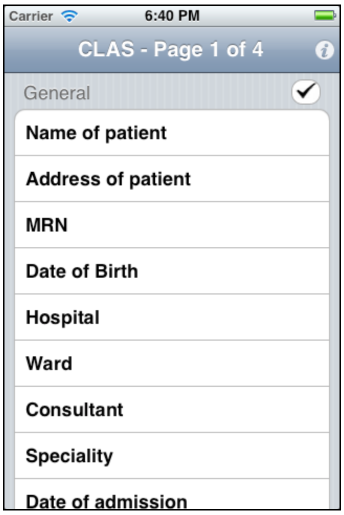


Figure 1: Screenshot of the CLAS App opening page.

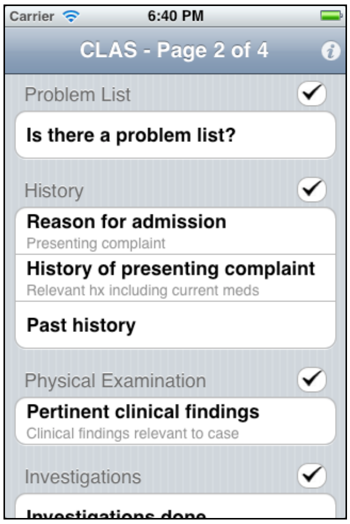
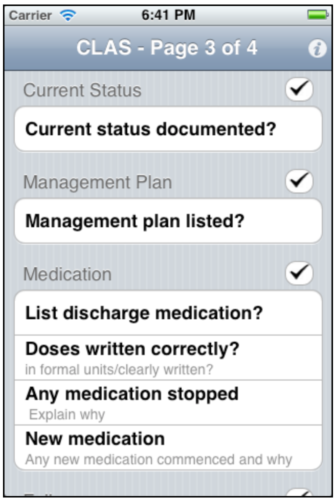


Figure 2: Screenshot of important content in a discharge letter.

During the development process of the CLAS App, we recognized the following issues. There is always a danger of over-crowding the screen and particular care has to be taken when transferring information from existing websites in order to condense the information as much as possible. Like good writing style, every word must earn its place on a mobile application. Even spaces are limited for each line, so wording has to be very succinct while remaining clear. Constantly re-writing and 'tweaking' of text according to user feedback on ease of use and clarity, is essential. Of course, mobile applications have the important advantage of being able to be modified and improved. New features can be added and problems fixed. Thus, mobile applications offer a dynamic, versatile and responsive component to 21st century learning.



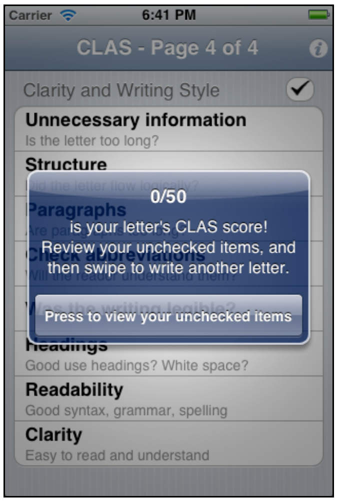


Figure 3: Screenshot of important medication details required for a discharge letter.

Figure 4: Final screenshot of the CLAS App providing overall CLAS score and prompting review of unchecked items.

FUTURE RESEARCH AND DEVELOPMENT

The CLAS mobile application is currently the basic of two research projects.

1. Assessment of the quality of 200 hospital discharge letters using the CLAS scale.
2. Assessment of the effect of the CLAS intervention on the letter-writing skills of 80 fourth year medical students.

CLAS Intervention Study

In this study, 40 4th year medical students wrote a hospital discharge letter (based on fictional casenotes made available to the students prior to the teaching session). These students were then given instruction on using the CLAS scale to write a hospital discharge letter. Another group (40 students) received the CLAS instruction first, and then wrote the hospital discharge letter. The discharge letters were then graded using the CLAS scale and the results of the two groups compared.

Results

Overall CLAS score in the control group was 26/50 and 42.5/50 in the intervention group. Instruction on the CLAS scale improved the overall CLAS score ($p<0.001$ -Mann Whitney U Test for non-parametric data).

Many individual items showed a statistically significant increased score in the intervention group. These items included all items in the medication group and management plan ($p<0.001$ using Mann Whitney U test).

The Chi-squared test was used for the remaining items; Address ($p<0.001$), MRN ($p=0.001$), DOB ($p=0.007$), Ward ($p<0.001$), Admission date ($p<0.001$), Problem list ($p<0.001$), Presenting complaint ($p=0.002$), Details of presenting complaint ($p<0.001$), Past history ($p<0.001$), Clinical Findings ($p<0.001$), List Investigations ($p<0.001$), Abnormal results ($p<0.001$), List Diagnoses ($p<0.001$), New diagnosis ($p=0.005$), Clinical Course ($p=0.002$), Current status ($p<0.001$), Follow-up ($p<0.001$), Other appointments ($p<0.001$), Sign off name ($p<0.001$), Title ($p<0.001$), Contact no./bleep ($p<0.001$).

In addition to actual content, structure ($p=0.014$) and clarity ($p=0.005$) of the letters improved after CLAS instruction and the students used headings more ($p<0.001$).

These results suggest evidence for the benefits of the CLAS scale as an educational tool to help medical students write hospital discharge letters.

The CLAS mobile application is relevant to handover in all healthcare transitions i.e nursing, mental health, physiotherapy. The principles of patient presentation - what the problem was and what was done about it, remain the same.

The CLAS application could be applied to health information technology systems to develop or revise patient discharge letter templates. Computer-assisted programmes have the potential to quickly extract information about diagnoses, medications, and test results into a structured discharge document. However, computer-generated reports always need clinician review and the addition of other information such as specific instructions regarding pending test results or the reasons why a particular medication was stopped. Ideally, information should be sent to the patient's family doctor in more than one way i.e. discharge letter given to patient and letter also emailed/faxed to doctor.

The CLAS scale is the first step in a suite of point of practice services for junior doctors to improve patient safety and minimise risk of medical error at handover. In addition to intern training, it can be used to teach medical students and also as part of induction and orientation training for junior doctors beginning new rotations. Key elements of good communication skills underlie the content of CLAS, thus it can also be used in communication skills training. The format of the CLAS mobile application is also being used to develop other point-of-practice healthcare checklists.

These applications focus on improving information transfer, the provision of clinical tools and the organization of knowledge resources so that patient care can be optimised, medical error minimised and a standard approach can be used for handover communications.

Mobile applications such as CLAS offer exciting opportunities for improving patient safety and minimising medical error at handover and are just the tip of the iceberg with regard to harnessing the vast potential of mobile communications and how we, as medical professionals, interact with each other and more importantly, how we interact with our patients.

In the near future, we aim to further improve the CLAS App with typical mobile application features such as taking into account sensor information from the mobile device such as GPS coordinates and audio recordings. In addition, we want to make the CLAS App more interactive by enabling users to synchronise handover information, thus improving the quality of information transfer at handover.

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Global MedAid – evolution of an mlearning app for international work-based learners

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ABSTRACT

This paper outlines an ambitious global mlearning solution called 'Global MedAid', which aims to provide learning resources and tools for personnel in disaster or emergency situations. It outlines the development process and, in doing so, presents the design considerations and solutions for developing a cross-platform application, which combines a wide range of media types for web-based, online and off-line use. The resulting prototype application combines elements of mlearning alongside appropriate tools for use by field workers and personnel with a variety of roles and shows how partners and users have been involved in the design process.

Author Keywords

work-based learning, defense, mlearning, training, deployment, support tools, productivity tools, smartphones

INTRODUCTION

Over the last two years, there has been a sharp increase globally in the number of mobile phones in use. The ITU annual report shows that there are now nearly 6 billion mobile-cellular subscriptions worldwide (International Telecommunication Union, 2011). In parallel, there has also been an increase in the uptake of smartphones: phones which combine the functions of a personal digital assistant, a mobile phone, a mobile media player and a camera. In 2011 over 85% of new handsets were able to access the mobile Web. In many parts of the world, smartphones are on the way to replacing laptops and other computers, and have become, for many people working in the northern hemisphere, an indispensible personal and working aid. In the developing world, the mobile has become an essential survival tool, such as providing the ability to receive vital weather forecasts and allowing users to bank remotely (for examples, see Kiwanja.net http://www.kiwanja.net/projects.htm). Health care has also been supported via mobile in a variety of ways, including using the short messaging service (sms) for reminders about medication (see for example WelTelKenya, reported in the Lancet http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(10)61997-6/abstract).

From an educational perspective it is now accepted that mobile devices have a number of important characteristics which make them attractive, including increasing portability, functionality, multimedia convergence, ubiquity, personal ownership, social interactivity, context sensitivity, location awareness, connectivity and personalisation (Pachler et al, 2010). Educationalists and trainers are thus considering ways in which the devices and applications can provide learning resources and tools that are available in the learner's pocket for timely use, an aspect proposed by Wishart and Green (2009). Furthermore, in this collection of concepts and cases of mobile learning in work environments, there are numerous examples of how mobile devices foster situated approaches to learning in and across work contexts (Pachler et al., 2011). However the notion of mobility relates not just to physical mobility (of the device or the user), but the opportunity to overcome physical constraints by having access to people and digital learning resources, regardless of place and time (Kukulska-Hulme, 2010).

It was within this context that the MoLE (Mobile Learning Environment) project was funded, a multinational technology research project sponsored by the U.S. military as part of its Coalition Warfare Program, which takes a multidimensional approach to fostering cooperative projects that enhance interoperability between U.S. forces and coalition partners worldwide. The emphasis was on solutions that would offer combatant commanders the capabilities of portability and field-ability in developing solutions that are applicable to multiple combatant commands and that will reach warfighters quickly.

The project has involved participants from up to 24 nations globally, and aimed to investigate whether the utility of mobile technologies could be harnessed to prepare personnel for a disaster or emergency situation, and provide a useful resource during an actual event. The main goal was to leverage mobile technologies and the global telecommunications infrastructure to facilitate the sharing of knowledge and resources between the partners across the world.

BACKGROUND RESEARCH

Tribal's role in the project was as technical expert. As a leading developer of mobile learning content, the goal was to develop innovative technical and training solutions to meet the challenges of meeting the needs of a diverse range of both contexts and personnel. Embarking on such a global solution required much up-front research, mainly because there was no existing research that had sufficient global reach and focused on all of the domain areas required. Thus, the first stage in the development process was to conduct background research into the current mobile situation globally, for example, which devices were being used across the world, which mobile companies were involved and what was their reach within the participating counties, the socio- and economic impact of mobile phones and wireless internet across the developing world, what were people using their phones and/or other devices to do, what were the issues globally? The project also considered the needs of this diverse range of users across the world, with a view to determining the types of content and tools that would be required to meet the aims of the project and the funder's requirements.

The research also uncovered several critical reports and reference sites (see for example W3C: Mobile Web for Social Development Roadmap : http://www.w3.org/TR/mw4d-roadmap/) that proved crucial to the ongoing project, for example on global mobile statistics and mobile usage. These were integrated into a project report that collected all the research data gathered. Highlights of this research, and links to key sources are available on the MoLE project website (see www.mole-project.net/research).

App Research

In addition to the desk research outlined above, hundreds of mobile medical and productivity apps (applications) were evaluated and compared to build baseline data about the potential core functionality that would be required, and also to compare design features and usability aspects. The majority of these mobile apps were not directly applicable to the project, but had features or functionality which were felt to be useful reference points. In summary, we found:

- very few apps that were directly relevant to the needs of Humanitarian Assistance, or Medical Stability Operations (MSO);
- many apps that provided specific productivity functions (e.g. 'to do lists');
- many apps that covered health or medical information, but very few which were of a sufficiently acceptable high quality, in that they had up-to-date or relevant content, suitable design features or desired functionality;
- many more relevant apps for the iPhone than for Android devices, and even fewer for Blackberry.

The most useful, or relevant apps were installed on demo devices, and shared with all the partners (in each nation) and key stakeholders.

User Surveys

MoLE partners also contributed to the baseline data via three different sources:

- DMRTI (The Defense Medical Readiness Training Institute) a US-based training facility that prepares military staff for humanitarian aid missions surveyed their students on their smartphone use and its perceived appropriateness for mlearning.
- The UK Ministry of Defence surveyed a cohort of their staff, asking similar questions. These were a broader group, not especially focused on disaster relief operations.
- The partner nations taking part in the MoLE project all provided their own survey responses, which provided additional data from a potential target user group i.e. medical and military personnel, and those involved in relief operations.

Whilst the background research uncovered some useful examples of medical information and productivity tools, it confirmed that a bespoke app would need to be developed to meet the specific needs of the project. Because the potential user group was broad, covering both medical and non-medical personnel, and a range of possible missions, the content needed to be similarly broad, but still of sufficient depth to be relevant and useful. Also, the development of mobile courses that would be appropriate for the target user group was an aspect of the project that made it different from the types of commercial apps available at the time of this initial research. What the team wanted to create was a tool and an information source, combined with just-in-time mlearning that could meet the needs of this broad spectrum of users.

MODELLING AND DESIGN OF THE APP

Making use of all the research data gathered, the core project team developed the initial proposition, and designed, via an iterative process, early prototypes of how the MoLE mlearning app might look and function. This proved to be quite complex, as the process of prototyping exposed the previously understated issue of the wide range of potential users, and therefore the difficulty in identifying single sources of content, or single functional requirements that would suit all users.

A Kick off Project meeting for partners was held in February 2011 in London. In preparation for this, the team produced a short film to assist participants and other interested parties to understand the disaster / relief scenarios the app was being created to deal with, and the typical users who would most benefit from the kinds of content and tools that were under consideration. It was used to help them think through a possible scenario and potential uses of mobile technologies, and to come up with suggestions and ideas for both content and exploiting the affordances of mobile devices, appropriate to a broad context of use. The meeting was attended by partner nations including a range of personnel with military and NGO (non-governmental organisations) backgrounds, many of whom had experience of deployment in austere situations. During the workshop, delegates worked in groups to suggest possible types of content and mobile solutions for the different stages in a mission.

The project funders were especially interested in how technologies and information could be shared between the multiple stakeholders in an emergency relief situation, which would include both military and civilian workforces from several nations. They wanted the app to offer mobile learning tools and techniques to help improve their preparation and productivity on the job. It was thus important that the app represented the three very distinct stages of activity for MSO (Medical Stability Operations) workers: preparation before they go on a mission, refresher info en route, and job aids for when they get there. Typical content needed to include:

- compliance training (compulsory courses that need to be taken pre-mission)
- information (generic information about countries, disaster relief and medical emergencies and more specific information relating to disasters)
- inventory management and logistical information
- practical solutions to problems (staff protection and safety, delivering medical care, working with partners, working with the local population).

The meeting was thus instrumental in helping to frame possible areas of content the app should contain and the types of content that could be realised for mobile devices.

Development of the content and menu design

One of the content development challenges was for the app to demonstrate the ability of a mobile device to provide a range of users with quick and efficient access to useful and relevant materials. This needed to be available in a variety of contexts, including the more challenging scenarios of disaster relief. The smartphone has many integral functions that could be exploited in a range of circumstances, and its growing ubiquity meant that few barriers to its broad usability were anticipated. Context and location-aware materials (for example making use of GPS) bring many benefits to mobile applications, particularly to users out in the field (Smith et al., 2011). Similarly, the already understood acceptance that the mobile phone, and even more so the smartphone, has blurred the barriers between work and play, and formal/informal approaches to learning and training, was also a plus in the choice of both content and design (Cook et al, 2006).

A key issue was that of size: adapting heavy courses or reference material for use on a mobile device requires skill and ingenuity, and a clear understanding of what is, and is not, possible and desirable. Some of these design issues are discussed in Parsons et al. (2007) and Bradley et al. (2009). A recent development in the massive improvement in the quality of 'e-readers' for smartphones, enabled the team to see the advantages of including manuals such as the Sphere Handbook into the app. At the other end of the scale, the ability to adapt and enhance paper-based checklists was an opportunity to play to the strengths of both the smartphone and what was felt to be the user's familiarity with app-type resources: easily accessed and simple to use, and available at the press of a button. A further challenge was that of connectivity: there was a need to provide within the app itself sufficient resources (without overloading the device) that could function off-line, in areas of no connectivity. At the same time, the content team had to consider the usefulness of being able to record and then share information with others, when connectivity is available.

The original planning and design exercise was expanded, in response to several opportunities which arose to do more active content capture and conversion, including:

- Video interviews with key MSO (Medical Stability Operations) thinkers: this provided a direct human interface/portal to dense informational texts such as the 'NGO Guide'.
- Conversion of elearning courses in Combating Trafficking in Persons (CTIP): this allowed for experimentation in converting elearning materials into an mlearning format, and in particular making best use of the affordances of the mobile device and adapting content for the smaller screen.

A limited amount of existing resources contributed by partners were repurposed and enhanced, and other sources were used to create a series of engaging and useful activities. The design challenge was to mesh together the mobile aspects of a just-in-time, just enough, easily accessible and appropriate for context, resource, with some of the more traditional mlearning elements, and also include a mechanism for getting user evaluation on the app. Technical and design aspects in relation to screen size, mobile affordances and navigation were also factored into the process. The affordances of both mlearning resources and the apps that were researched, were all taken into account in both the planning and the development of the activities that went into the app. For a wider discussion of some of the design challenges involved in developing the app see Towards Open Formats for Mobile Learning (Stead, 2012).

First version of the app

The above discussions and partner contributions led to the development of the first version of the app which was structured around the three stages of deployment: get ready, en route and on the ground (see Figure 1). Each of these three stages contained content that had been supplied by partners and adapted by the content team, or developed independently by them. Each deployment phase had content that was appropriate for each phase, and categorised as learning materials, checklists and reference materials, as follows:

- **Get ready**: contained a training course *Combating Trafficking in Persons* which had been adapted from a mandatory elearning course, which all DoD (United States Department of Defense) and other deploying personnel are required to complete, and a series of checklists, adapted from paper-based lists supplied to deploying personnel by the United States military, to help with packing and pre-deployment essentials.

- **En route**: checklists, for example for a nuclear radiation scenario, learning materials that help personnel recognise NGO logos, and video-based reference materials (a discussion about the issues arising when military and NGO personnel work together in a disaster scenario).
- **On the ground**: this section only contained reference materials, such as relevant documents on ethical topics.

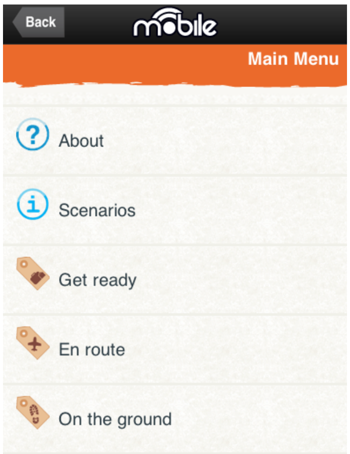

Figure 1. The MoLE App menu screen in Version 1

Technically, the app was authored as an open, extensible mobile learning capability that includes:

- Cross platform performance: an extensible Mobile Application Layer supports mobile learning content on both Apple and Android devices.
- Multiple contexts of use: media and learning resources are drawn from multiple partners, and designed for various contexts of use, e.g. for reference, as a course, as performance support, as an 'on-the-job' aid.
- Integration with traditional architectures: usage tracking and evidence from the app's use is saved to a traditional learning management system (LMS).

For more details of the technical considerations taken into account see the project report Cross-platform Mobile Development (Hartmann et al., 2011).

Some examples from the mlearning course for 'Combating Trafficking in Persons' are shown below in Figure 2.

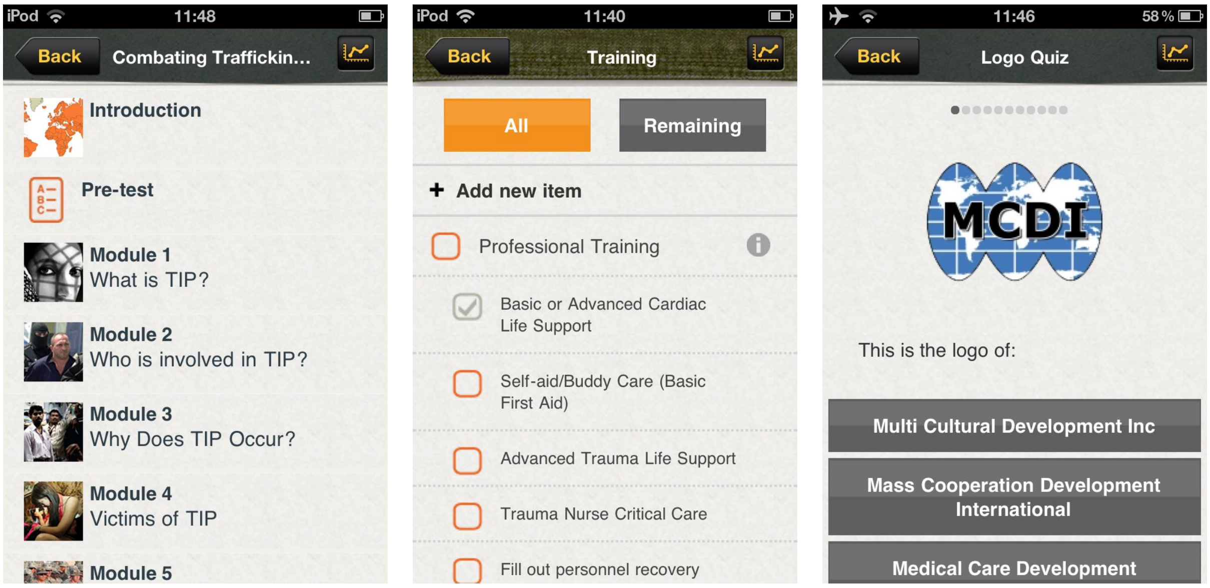

Figure 2: Examples of content screens

VERSION 1 USABILITY REVIEWS

Once the first version of the app had been authored and the content created, Tribal followed its internal process protocol of iterative usability reviews with untrained reviewers to evaluate and refine the user experience. This process assists in the identification of any key usability, technical or practical issues in advance of the wide-scale Proof of Concept trialling scheduled from April 2012.

Based on good practice recommendations from Nielsen (Nielsen, 2000), five end-users with military and non-military backgrounds were selected. Each was presented with a sample disaster scenario, and asked to step through the app in the role of a specified member of the team. Whilst the tasks were unlikely to be seen as 'realistic', the aim was to help the user engage with the app so that they could give feedback on navigation, ease of use and suitability of the content. The content in the app at this stage was oriented to US military personnel and NGOs who work alongside US military (including the Combating Trafficking in Persons compliance course) but nevertheless approximated the kind of reference materials and productivity tools likely to be of use to military personnel and other groups in similar circumstances.

In terms of the suitability of the mobile app and its content, the response from the five users was generally positive, with comments such as:

> "The Tip course is a useful way to get the information across." (User 1)
>
> "The content is pretty intuitive." (User 2)
>
> "Checklists are a good thing to have: even better if you could add your own." (User 1)

The main result from the testing however, was that the arrangement of the content into deployment phases was not felt to be intuitive, and consequently the menu was redesigned into categories (see Figure 3). This is also in line with current views about mobility and content, as summed up by Traxler, "mobile devices demolish the need to tie the particular activities to particular places or particular time" (Traxler 2011). Changes were also made to navigation and functionality, and a search facility was added to the Library section, which had also been suggested by the testing group.

Figure 3: The revised Global MedAid App menu screen

NEW CONTENT

The redesign of the menu and app structure opened up more possibilities for content, e.g., the University of Miami provided instructional videos for treating trauma injuries (see Figure 2). The availability of these short, focussed resources for users is very valuable, but installing them all within the app can easily overload the device. The compromise position reached was to provide some videos within the app and provide a link to further ones when a connection opportunity arose. The NGO guide was added as an e-book, along with the Sphere Guide. It was still felt that more use should be made of the collaborative possibilities of the device itself, and first versions of a 'network' section with a collaborative yellow pages was developed, for personnel to use and share information about organisations in specific areas. This more collaborative aspect of the app, and further uses of the functions of the phone, such as camera, audio etc. need further development in future versions of the app. As the latest Horizon Report says, "the best apps are tightly integrated with the capabilities of the device itself, using location data, motion detection, gestures, access to social networks, and web search, to seamlessly create a full-featured experience" (NMC Horizon Report Higher Ed Edition, 2012).

EVALUATION

The testing of Version 1 of the app resulted in amendments, as discussed above, and the creation of a 'Proof of Concept' (PoC), to be evaluated across the partnership from April to June 2012. The evaluation was designed to allow the MoLE Project to get feedback from target users, including personnel from military and non-military backgrounds, some of whom have a medical background. The aims were to test the effectiveness of the tool that has been developed, and in particular how capable mobile learning technology is of addressing the emerging requirement to provide training and performance support tools in austere circumstances.

One particularly challenging aspect of the evaluation was the very diverse nature of the participants: geographically, culturally and professionally. A volunteer could be using one of over 20 different supported smartphones, from one of over 20 nations. Trials spanned from outdoor training sessions in South Africa, to University based trials in Georgia, to the Fire and Rescue service in Germany. To ensure maximum ease of data collection, the collation of evaluation data was done entirely on the smartphone, as an integral part of the Global MedAid app. The evaluation process used a mixed-method approach designed to produce both quantitative and qualitative data (Punch, 2009), by collecting a blend of formal evaluation questions and informal tracking data as participants used the app.

Participants completed an online demographic questionnaire before being guided to install the Global MedAid app from their local app store, using a provided pin code to access it. This gave them access to the full app, and all content. In addition, an “evaluation” button was available on all screens, to launch the evaluation layer (survey). This survey guided each user through a series of tasks in the app, taking them through envisaged steps of deployment, and to those parts of the app which would be appropriate and useful at each stage. For example, the participant was asked to navigate to Mission Tools, look at a preparatory checklist, and to add an item of their own choice which they considered to be of use. After each task, they were then asked a series of questions designed to provide quantitative data, which focus on the self-efficacy, utility, usefulness and accessibility of the app. Qualitative data was sought through free text questions in which they were asked to relate their experience of using the app, and say what they liked and didn’t like about it. In addition to the formal evaluation questions, user activity in the app was tracked, and data collected to correlate against their answers. The evaluation questions were available in multiple languages, to suit individual nations.

Participants in the PoC were guided by local coordinators from each nation who had taken part in a preparatory workshop held in the UK and had access to supporting materials, such as “how-to” guides, and an introductory video to share with delegates. These resources are available on the project website at http://www.mole-project.net/evaluation/intro

Initial evaluation findings

Project partners are in the process of analysing all the data and producing a full evaluation report, but some of the initial findings are presented here, to illustrate how the users found the app.

The users

24 countries[1] initially volunteered to participate in the PoC, but only 21 took part in the evaluation. 268 people took an initial demographic survey then installed, and used the app. Of those, 177 people started the evaluation and 137 completed it. The majority of those who started were males (67.5%), many over 30 years old (78%). Their areas of professional expertise were as follows: 34% medical, 26% elearning, 11% training, 1% rescue, and 25% ‘other’ (2% didn’t answer the question). Only 29% had previously been involved in humanitarian assistance or disaster relief operations, and 17% had taken the CTIP course as an e-learning course in the preceding 2 years. In terms of their technology choices 63% were using an iPhone (37% an Android phone), and the majority (71%), were using their own, personal phone (29% were borrowing one for the trial). They were asked to rate the question ‘How comfortable are you with using the mobile device that’s running the MoLE app?’ on a 7-point Likert scale, with 1 being low (beginner) and 7 high (advanced user). The mean score was 3.99, but 38% rated 1-3, 14% rated 4 and 47% rated 5-7, so more users were comfortable using their device than those who were not. As you might expect, those using their own device were more comfortable with using it, with a mean rating of 4.35 compared to 3.15 for those using a loaned device. Looking at the tracking data generated from use of the app, users accessed it on average 9.83 times, but one user accessed it 79 times.

Initial analysis of the results

The full evaluation of the trial is still in progress, and seeks to understand the self-efficacy, utility, usefulness and accessibility (usability) of the app by correlating answers to a range of questions with observed behaviours from participants. Most of these questions used the same 7-point Likert scale used in the demographic questionnaire, with 1 being low and 7 high. Participants were asked to use all the core sections of the app, during the 3 simulated stages of their deployment, enabling the collection of their views across the many different content types, and tools. These included structured courses (Tip), video interviews, reference guides, eBooks, checklists and other productivity tools.

To provide more meaningful qualitative feedback, they were asked to answer this question: ‘Please write up to five single words which best describe your overall experience of using the mobile device as a tool for learning’. Some wrote a phrase rather than five descriptive words, but the results are displayed in the Word Cloud below. The larger the font size, the more common the word.

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[1] The countries involved were: Azerbaijan, Belgium, Bulgaria, Canada, Chile, Egypt , France, Georgia,, Germany, Italy, Jordan, Mexico , Nigeria, Norway, Peru, Poland, Romania, Serbia, Singapore, South Africa, Switzerland, UK, Ukraine, USA.

Figure 4: The words users used to describe their overall experience of using the mobile device as a tool for learning

105 participants responded to this question. The most commonly used descriptive word was that it was “interesting” (23 times), followed by “easy” (19), “useful” (17), “easy to use” (10), “convenient” (9), “simple” (9), “informative” (9), “fun” (8), “accessible” (6), and “fast” (6). Another 5 responses said it was “speedy” and “practical”, and 4 described it as “efficient”, “flexible” “friendly”, “good” and “mobile”. The only negative comments made three or more times was that it was “challenging” (3 users) and “frustrating” (3). Very few responses were wholly negative (4 out of 105) – most users balanced negative points with positive ones.

Discussion

Overall the users have given a very positive response to the app, across all the sections. The responses relating to the questions on utility show that a high proportion of users found that mobile devices were useful for providing this type of training, which is also reflected in 17 users using the word “useful” in the free text question. Other comments made were that the app is “practical’, “convenient”, “handy” and “flexible”, these last three all being characteristics usually associated with mobile learning applications. Usefulness is not discussed here, as it was mainly being measured by some of the transparent data collected through use of the app, which has not been presented in this paper.

In terms of self-efficacy, the majority of users found the content within the app to be effective. The word “interesting” occurred 23 times, with 8 users saying that it was “fun” and 3 “educational” and “engaging”. Such opinions are obviously important in securing user motivation to use, and continuously use an app. Other comments were that it was “informative”, “simple”, “effective” and “good”.

Accessibility (or usability) saw more mixed reactions. There are clearly some accessibility issues that need to be considered for further development of the app. Some users had issues with the navigation, saying that it was “poor” or “hard”, or that it was “confusing” and “unintuitive”, and some commented that “the screen was too small”. But in reality the number of users who made these comments was low (2 or less). These comments should be looked into in more detail to see if these users were disadvantaged in any way, for example by using a loaned and unfamiliar device. Conversely, more users said it was “easy to use”, “accessible”, “fast” and “friendly”, so the majority of users did not have accessibility issues.

CONCLUSION

The MoLE project and the development of the Proof of Concept of the Global MedAid app has been a major undertaking, involving the collaboration of many nations working together to establish resources that can help those who venture into difficult environments in a variety of roles. The project has created a technical approach to delivering this ambitious set of resources for on-line and off-line access and whilst it has not yet been tested ‘out in the field’, the app and its contents have been well-received by those who have used it. Participants seemed to appreciate the full range of media, and interactivity types, from structured training courses to more immediate reference tools. Clearly, a full statistical analysis of the individual quantitative questions with a full analysis of the qualitative data needs to be undertaken, and at the time of writing this is in progress. However, based on this initial analysis of the results from evaluating the app, a number of conclusions can be drawn. The users thought that having this type of training available on mobile devices is useful, finding the app “convenient”, “handy” and “flexible”. This goes some way to justifying the original proposition: that mobile access to on-the-job learning and support materials is an effective and efficient way to support professionals working in medical and stability operations. Not only was the app considered to be useful, but it was also effective, and even “interesting”, “fun” and “practical”. The majority of users also found the app to be accessible and usable, for example it was “easy to use”, “fast” and “friendly”, although a small number experienced some issues with navigation (which needs looking into further) and the small screen of the mobile device.

Further testing will be carried out in 2013, using a refined version of the app, to include a new Network section and reworked Library. It is anticipated that the app will be trialled by personnel on a deployment-style exercise, carried out by US military personnel and others. Future iterations of the app will allow professionals to add or adapt content for specific circumstances.

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Designing Mobile Applications to support type 1 diabetes education

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ABSTRACT

The growth in Internet usage has become increasingly important to adolescents who now use it with more frequency to search for health related information. Parallel to this growth, mobile devices have become progressively more flexible and capable of handling an increased range of functionality. They have begun to be viewed as a viable means of improving communication between health practitioners and patients, which could help to alleviate the disease burden by reducing costs through admission reduction and long-term complications in a variety of long-term conditions. This study explores what young people aged between 18 and 21 with type 1 diabetes feel about their use of mobile and web-based technology and whether it might enable them to engage in an improved way with the NHS and their own health to enhance health-related quality of life. It is intended to identify from their views and experiences how they currently make use of web and mobile technology in their day-to-day lives and in relation to their condition and treatment. To then build a small number of prototype mobile phone applications based on ideas collected during qualitative data collection. Four years into the project, this paper disseminates progress to date and provides an innovative example of how patient education can be designed in a way which meets the needs of a particular patient group and values and encourages their input to assist in the creative process - whilst also conforming to clinical guidelines.

Author Keywords

patient education, type 1 diabetes, alcohol, hypoglycaemia, illness, twitter, mobile, apps, sociotechnical design, lifeworld, humanising healthcare, patient voice, empathy, phonegap

BACKGROUND

Diabetes is a long-term condition (LTC) caused by too much glucose, a type of sugar, in the blood. In England, 2.5 million people have been diagnosed with diabetes and the number is expected to reach 4.2 million by 2025. The number of prescriptions for treating diabetes in England has increased to over 40 million - a 50% rise in six years and a 6.1% (2.3 million) rise on the number of items prescribed during 2010-11 (BBC News Online, 2012). *Type 1 diabetes* occurs when the body produces no insulin (NHS Choices, 2010). It is sometimes known as juvenile diabetes or early-onset diabetes because it usually develops before the age of 40, often during teenage years. Someone who has type 1 diabetes usually needs to take insulin injections for life and must make sure that their blood glucose levels stay balanced by eating a healthy diet and carrying out regular blood tests. Type 1 diabetes accounts for 10% of all people in the UK with diabetes and 90% of young people with diabetes (Diabetes.co.uk, 2012).

Two-thirds of the world's population – over 4 billion people – now has access to a mobile phone (Naughton, 2012). New mobile devices have become progressively more flexible and are now able to handle an increased range of functionality including the ability to access the Internet and locative technology. Adoption of mobile phone technology is being led by 16 to 24 year-olds, with 44% using a mobile phone to access the Internet (ONS, 2010). Mobile applications (Apps) harness the power of the Internet with the simplicity of multi-touch technology on a small screen and can run on computers, Smartphones or tablets like Apple's iPad. As of March 2012, 315 million worldwide users had downloaded 25 billion Apps from Apple's App Store and it now offers over 550,000 different Apps including a variety of health based ones (Apple, 2012). Health Apps offer tremendous potential as they can be specifically geared towards particular conditions and purposes or focus on providing support for specific users (e.g. practitioner, patient and carer communities). However an App requires careful design to suit the mobile platform and to ensure that it is clinically accurate and fully considers the individual needs of its users. Consideration also needs to be given to how effectively Apps might be deployed and utilised across different healthcare settings and how they are supported technically. Due to their mostly commercial nature, at this point in time there is little research related to the design process, development and use of health-related Apps by individuals or groups, although this will certainly alter as more mobile devices and Apps are distributed and used in different healthcare settings.

As there is currently little analysis of how young people with type 1 diabetes make use of web and mobile technology and its impact on health-related quality of life (HRQOL), the research question was:

> *How do young adults with type 1 diabetes engage with web and mobile technology in their day-to-day life and how might this be related to their health-related quality of life?*

This paper begins by discussing how the study contributes to new knowledge and then continues with the motivation behind the study and the methodological and theoretical considerations which underpin it. It then describes the methods utilised, and provides a brief overview of the four prototype Apps currently in development. It concludes by reflecting on the research journey to date, four years into the study.

CONTRIBUTION

This study contributes to new knowledge in three areas:

Contribution to Young People's Lives

Published research considering the views of young people with type 1 diabetes in their use of technology to support their condition is sparse. There is little to analyse considering how they currently use web and mobile technology and its impact on their HRQOL.

Contribution to Technical Development Process

There is little research relating to the design and use of health-related diabetes Apps. However, one of the only reviews of features of mobile diabetes applications (Chomutare et al., 2011) found that a critical feature recommended by clinical guidelines - personalised education - was not included in any current App – an area this study is interested in.

Contribution To Technology

Research and policy concerning the integration of health information and support with technology do not effectively consider the viewpoint of the patient. In terms of type 1 diabetes, young people's views are vitally important as they have a radically different view of technology than either their peers or practitioners.

MOTIVATION

It is thought that education via access to information about diabetes could help people with the condition to empower themselves to manage it more effectively, thereby reducing complications. Van Dam et al. (2005) acknowledged that better knowledge of the ways in which social support operated was vital for enhancing diabetes patient self-care, insuring adherence to advice from professionals, encouraging lifestyle changes and helping to improve outcomes of care and increase personal freedom. Öhman et al. (2003) suggested that it was important to gain a deeper understanding of how chronically ill people experienced illness and life in order to understand the illness from the perspective of the individual and their relationships with family, friends, carers and health professionals. By considering the nature of people's needs who live with chronic illness and reflecting on how they cope and adapt to their situation it enables us to obtain a better foundation for understanding systems which might have a rational basis for helping them. As an example, it has been suggested that practitioners might like to consider how best to meet the needs of young people with diabetes by seeking to understand their experiences and the social networks in which they are embedded, alongside how self-management might be supported by healthcare (Allen and Gregory, 2009). Lamb (2012, p.202) also recommended that clinicians involved in the care for young people with type 1 diabetes should explore the online forum contributions of adolescent experiences as they made sobering reading.

The use of just phone functionality for clinical interventions has to date shown little actual impact. A recent study showed traditional cognitive behaviour interventions like educational sessions through phone calls had little value in changing negative health behaviours in children with type 1 diabetes (Salamon et al., 2010). However, in the same year, Bowen et al. (2010) noted that young adults with diabetes had expressed an interest in email and mobile text messaging in previous studies to enhance disease management and that text messaging had been proven to be beneficial as a possible motivational tool (Franklin et al., 2003). In the case of type 1 diabetes, Lamb's article (2012) on integrating technology into adolescent diabetes care suggested that adolescence tended to conflict with the management of chronic conditions and that interventions utilised previously like telephones, mobile phones and text messaging might seem to empower individuals but had little to no effect on metabolic control in young adults. Williamson (2010) suggested that new technology should still be explored as a possible means of communicating with patients – an approach which could be simply applied to a new diabetes App on a mobile phone, always near to them - joining the growing number of existing Apps available (Chomutare et al., 2011; Cafazzo et al., 2012) or as a part of a mobile friendly assistive device related to their condition (Sanofi, 2011). As an example, a young person with type 1 diabetes who was just diagnosed might be given access to a mobile device or App which played an audio or visual introductory guide to the condition in a friendly non-threatening manner, directly after an initial appointment. Other examples might include an App as an alternative approach helping to counter the high rates of non-attendance at clinics by young people after transfer to adult services - associated with poorer glycaemic control compared to those who visit clinics (Masding et al., 2010). For self-monitoring of blood glucose, it could enable patients to act on their blood glucose results, transfer and manage blood glucose data, assist with interpretation and support behavioural changes (Kerr et al., 2011).

THEORETICAL ASPECTS AND RELATED WORK

Morse (2012, p.21) defined *Qualitative Health Research* as:

> *A research approach to exploring health and illness as they are perceived by the people themselves, rather than from the researcher's perspective.*

Researchers use qualitative research methods to elicit emotions and perspectives, beliefs and values, and actions and behaviors, and to understand the participant's responses to health and illness and the meanings they construct about their experience. She believed that the most important aspect of qualitative inquiry was its moral imperative to humanise healthcare, suggesting that a humanising health care agenda included identifying methods of evaluating humanising care at all levels of application and analysis, so that the research focus included individual's experiences and conceptualisations of well-being and quality of life (QOL). Husserl (1970) was seen as the founder of the phenomenological movement and tried to make the nature of human-world intimacy more explicit. He named this the *Lifeworld* – the world of lived experience or the beginning place-flow from which we divide up our experiences into more abstract categories and names (Dahlberg et al., 2009). In their article on the concept of lifeworld-led healthcare, Todres et al. (2007) revisited the potential of Husserl's notion of the lifeworld and theorised how lifeworld-led care might provide important ideas and values that were central to the humanisation of healthcare practice (Dahlberg et al., 2009). Most of the time in everyday life, the lifeworld is *Transparent* in the sense that day-to-day life *Just Happens*, grounded in spatial temporal parameters which are more or less regular (Seamon, 1979). However, an integral part of lived transparency is good health which is lived as a kind of tacit attunement, normally given no direct attention, whilst illness or disability activate a resistance to the lifeworld as they transform its transparency into awkwardness, unease or discomfort. This area of research aimed to construct a vivid lifeworld of the diagnosis, post diagnosis and the day-to-day lived experience and technology use of young people aged between 18 and 21 with type 1 diabetes by using in-depth qualitative interviewing. By talking to young people with type 1 diabetes in-depth and imagining *What it Was Like* (Todres, 2008) to be diagnosed with the condition and to have to continually examine food labels, looking for hidden sugars in food and drink which could affect control from a young age and remembering to take insulin injections at set times every single day for the rest of your life, the philosophy of understanding offered an important opportunity to integrate understandings about the young person's experience allowing the researcher to gain a deep personal insight into the life of the person experiencing type 1 diabetes day-to-day. How they encountered human services and relationships at home, at school, at work, in clinical environments and also within social contexts. Physicians and caregivers as well as adolescents with diabetes often experience frustration and powerlessness when adolescents repeatedly return to their clinics with poor metabolic control (Frøisland et al., 2012). The Lifeworld approach might also help to provide new insight into areas such as why blood glucose control is poorest between 18 and 21 (Lamb, 2012) and how there might be new, innovative ways which might help young people to improve this, or other aspects of their life and others diagnosed with type 1 diabetes in the future. An important point from Lamb's (2012) article on integrating technology into adolescent diabetes care theorised that technology could not yet remove the largely behavioural barriers to good diabetes control, but might sometimes offer another way of engaging an individual more closely.

There is little research considering the views of young people with diabetes in their use of new technology to support their everyday life with the condition. Franklin et al.'s (2003) study was of particular importance as it was the first randomised controlled trial, which explored the impact of text message enabled behavioural support, with intensive therapy in a young age group. However, the study made no mention of engaging with the targeted audience to discuss what they would like to use on which to influence the hypothesis at the heart of the study. Similarly, in their study reporting results from YourWay - an Internet-based self-management intervention for adolescents with type 1 diabetes - Mulvaney et al. (2010) stated that to their knowledge, this was the first trial of an Internet program to improve problem solving in type 1 diabetes adolescents. However this article again makes no mention of whether young people were asked their opinions during the design of the intervention itself. Although Chomutare et al. suggested (2011) that research has consistently shown that diabetes management is one area where mobile devices could enhance QOL for people living with LTCs, actual research evidence is hard to find (Holtz and Lauckner, 2012). Mulvaney et al. noted (2010) that little is currently known about how young people currently use mobile phones for diabetes and as yet only a small proportion of Apps available have been subjected to any research. One of the only reviews of features of mobile diabetes Apps by Chomutare et al. (2011) finding surprisingly that a critical feature strongly recommended by clinical guidelines - personalised education - was not included in current applications. Uniquely, this research aimed to give young people aged between 18 and 21 with type 1 diabetes a voice during qualitative interviewing which could then be used to create technological innovations which might benefit them in some way by the interpretation of their personal ideas and lifeworld experiences.

Existing definitions attempting to integrate technology with health are primarily concerned with using concepts and technology from the healthcare or medical perspective. Consequently, the thought of refining and using new technology alongside a new or pre-existing model of healthcare overshadows and does not effectively consider how this might work from the perspective of the patient at the centre. There is therefore a need to design a framework encompassing the use of web and mobile technology for patients with LTC. A framework originating from the patient's perspective which encapsulates the use of web and mobile technology for the benefit of those who might want to support, mitigate or improve their own QOL (Pulman, 2010). Hindmarsh thought (Vodafone Group, 2006, p.40) that we needed to think hard about what methods of communication a young adult in our rapidly advancing technological environment would be most likely to use in their day-to-day life and incorporate self management into the daily routine so that it became a normal activity rather than an inconvenience. This could be achieved by exploring what the preferred methods of communication were and then designing tools which enabled young adults to engage with the health service and their own health in their preferred manner, putting the individual in charge. Communication is important because management of the disease does not just require motivating the individual, getting them to change their behaviour, but also sustaining and monitoring that behaviour over many years. The last 20 years of diabetes education have reflected an increased emphasis on integrated educational strategies and collaboration with the patient (Frøisland et al., 2012). The aim of a design is to create something that fits, but creating something that fits comfortably and naturally is not always easy. Sociotechnical design is a response to the desire to create systems which are useful and apt (Faulkner, 2000, pp.78). In 2009, delegates participated in a sociotechnical Think-Tank which included the creation of a manifesto as a meeting action. In the manifesto, Clegg et al. (2010) argue that various sociotechnical principles are of direct relevance to current NHS information technology (IT) management, design, implementation and use. They discussed how their manifesto was based on the premise that through learning from past successes and problems in the health and social care sector and by applying sociotechnical principles to future projects, better health and care and value for money could be delivered. They also suggested that a key characteristic of sociotechnical thinking lay in its ability to highlight the importance of developing new ways of working which significantly met the needs of both clients (patients) and users (service providers). Sociotechnical approaches have started to appear in literature concerning diabetes research as a means of collecting data for designing systems to be used by clinical staff (Adaji et al., 2011) and patients (Ma et al., 2009).

This area of study hopes to address this in the creation of a new framework constructed on lifeworld understanding which humanises healthcare by creating technology using sociotechnical design principles. By using a lifeworld approach to help to understand more deeply their day-to-day life and the challenges they came across and including young people with type 1 diabetes in the process of generating technical ideas which might improve their HRQOL and then asking them to use and feedback on early iterations of anything developed, the intention was to provide a humanised approach to their healthcare which also gave them an active voice (at the same time as involving clinical staff, so that their feedback could also be considered and actioned). In summary, the researcher wished to:

- Gain a deep understanding of the perspective of young people with type 1 diabetes and connect with their perspective by building a picture of their lifeworld.

- Utilise this picture and perspective in creating a technological mobile aid partially created and influenced by their own opinions (and those of clinical staff) which would help to possibly humanise an aspect of their healthcare in relation to their condition and which might then improve an aspect of their HRQOL.

METHOD

Recruitment was conducted at a local district hospital in the South West (and a local University) with data collected by semi-structured, in-depth qualitative interviews. Nine one hour interviews were conducted and transcribed with patients aged between 18 and 21 with type 1 diabetes. Although the clinic had children under 18 attending, it was decided to focus on older members as this alleviated the need to obtain parental consent for participation. The upper limit of 21 for initial recruitment was set, as this was the age at which participants no longer attended the clinic on a regular basis. The sampling strategy utilised a non-random, convenience sample as selection would be from participants who had type 1 diabetes within the population definition. The sampling strategy would be purposive (non randomised) - the selection of participants who had knowledge or experience of the area being investigated - as selection would be from young people who had type 1 diabetes within the population definition. Besides providing an understanding of their lifeworld, the initial qualitative interviewing (n=4) enabled the identification of possible ideas for development of prototype Apps. After these interviews had been undertaken, baseline data analysis was undertaken to locate potential ideas for App development. A number of innovative ideas not currently available to participants were suggested during the interviews, of which four seemed strong contenders for developing into Apps after discussions with the clinical team at the local hospital. Prototype App development began in February 2012, which enabled demonstrations of the draft versions as a part of the interview process to take place from the fifth qualitative interview onwards. Working prototype versions of the Apps being developed were installed onto two iPod Touches which could be used by participants to evaluate the features and quality of the prototype Apps. Using an Apple Developer account, the iPod Touches could be configured so that a prototype App could be installed and piloted without the need to be published on the iTunes Store first. Development of prototype Apps on the iPhone platform can be easily transferred to other operating systems (e.g. Android, Windows and

Blackberry) as the Apps are being developed using the PhoneGap architecture. PhoneGap (2012) is an open source solution which allows users to author native Apps using web technologies like HTML, CSS and JavaScript and then deploy them across multiple platforms on different App stores. PhoneGap is an open source implementation of open standards and free to use, which means developers can use it in the production of mobile applications which are free, commercial or open source in design. A percentage of the time allocated in latter interviews (n=5), concentrated on ascertaining from the participants their feelings on the prototype App most closely aligned to their particular area of interest - highlighted by other sections of the interview process - to provide deep, meaningful feedback on the prototype. This was important as unstructured interviews - in terms of usability engineering - are able to provide a wealth of information that the interviewer might not anticipate (Faulkner, 2000). For latter interviews it was possible to utilise NVivo 9 to highlight, record and segregate the differing positive and negative comments on the prototype Apps described by interviewees and to subsequently feed this back into the design process (both for the developer – look and feel and navigation - and for clinical staff – textual content and the quality of information provided). NVivo is a software analysis package which helps to ensure that the analytical process is systematic, sequential and verifiable. Alongside the section of the qualitative interview which focused on garnering prototype App feedback, the researcher was also able to observe the interviewees (n=4) using the prototype Apps for a short, concentrated period of time. This assisted in demonstrating how they were using them and any problems that they might experience in selecting screens and working out how to use the Apps and navigate them, which would not come across from either listening to an audio recording or reading a transcription of an interview. So that the researcher could ensure from a clinical perspective that anything developed met the goals of the clinic, a questionnaire was also distributed to clinic staff that had first had a chance to try out one of the prototype Apps on one of the iPod Touches available for testing purposes. This provided another useful feedback loop on what was being developed.

INITIAL FINDINGS

Four prototype Apps were chosen for development based on the many ideas collected during the qualitative interview process. The suggestions chosen needed to meet clinical goals, reflect interviewee requirements and comments and follow hospital technological guidelines (as an example, patient data is currently not allowed to be recorded).

Diabetes and Illness Guide

If they feel unwell, people with diabetes need to take special care as any illness, even if not related to their diabetes (such as the flu), can cause their blood sugar (glucose) level to rise. The body's natural response to illness is to raise the circulating blood sugar level, but often this means that people with diabetes need to take a higher dose of insulin than usual, rather than cutting the dose or not taking any insulin. Reducing an insulin dose or stopping it altogether can lead to serious problems and often causes Diabetic Ketoacidosis, which requires hospital admission. Interviewees suggested that illness information provided on a mobile format would be positively received and utilised:

> ***P:*** *...So that when I feel ill, what to do. Cos like the guidance has changed like I was ill not long ago and I was told when I'm ill and I'm not in don't take one of my injections now I've been told that I've got to take it. The guidance like that was changed somewhere and basically it's been like that for all the time but we were told something completely different.* **[T1-QOL-01]**

> **P:** *Er the sort of things I guess people could do with knowing is when you're ill, like if you get athlete's foot or something someone's like oh you know that's 'cos of your diabetes. Well I've never been told that so I wouldn't of known that, you know, and it doesn't just come up on Google like oh you know what you can expect from being diabetic or why that headache is because you've got diabetes. Like everything is always…"oh that's because of your diabetes" and you think well I wouldn't have known that until this happened and so...* **[T1-QOL-03]**

Diabetes and Hypoglycaemia Guide

Hypoglycaemia means an abnormally low level of sugar (glucose) in the blood and is most commonly associated with diabetes. It can occur if someone with diabetes takes too much insulin, misses a meal, or exercises too hard. An App which provided information on what to do for patients, and providing advice on what to do for friends, family, work colleagues, school staff and other possible people who might come into contact with the participant were amongst the suggestions received around the areas of diabetes and hypoglycaemia:

> ***P:*** *...I think that, I think something that could just like, just something that basically, basically covers like basic um, common diabetic problems and er, like what to do in this situation so whilst you've if you've got like a friend and you're not really in a state, a friend who would, even if they know what to do but they've kind of gone out of what they need to do like not having any juice on hand.* **[T1-QOL-02]**

> ***P:****...I think it could probably be quite helpful to have the App, um, I don't know, I'm, I'm a big talker so I can, I'm quite happy to talk but if there was something on an App that made it clearer. I think it would be quite useful to, to show them, or tell them that they can read it themselves if they get it or…* **[T1-QOL-06]**

Diabetes and Alcohol Guide

Drinking alcohol increases the risk of hypoglycaemia (low blood glucose levels) in patients with type 1 diabetes. It is estimated that as many as one fifth of episodes of severe hypoglycemia are attributable to alcohol (Nilsson et al., 1988). Interviewees suggested that they would find a guide about alcohol limits particularly useful on a night out which could then be accessed via a mobile device:

> ***P:****…it's quite difficult when you've been diagnosed, especially if you've been drinking before, like what what…what each one will do, you know cider, beer, there's loads, and it would be nice to know what has, what has sugar in, what doesn't and something like that…* **[T1-QOL-06]**

> ***I:*** *…have they actually said at the clinic what you're, what they give, give you some ideas about what you should and shouldn't be drinking if you are drinking, in terms of different types of drinks or…*
> ***P:*** *Erm (thinking), they probably have, perhaps I didn't listen…(Laughs)* **[T1-QOL-07]**

Diabetes Centre Twitter News Feed

Social Networking Sites like Twitter and Facebook are increasingly being used for health-related purposes and recent work has highlighted their value in the field of health. Twitter is a microblogging application providing users with the ability to communicate through the exchange of answers to the question: What are you doing? It has evolved beyond this basic functionality to provide other alternate uses some of which could be health related (Pulman, 2009). Twitter was suggested as a tool which might have many benefits to a young person with type 1 diabetes either used directly or through integration with other Apps. Functionality suggested during interviews included a way to meet other people of a similar age with a similar lifestyle, as an emergency link for contacting people in the health service who might be able to assist at a particular point in time, receiving direct messages from clinic staff advising on reminders about taking insulin, coming to appointments and taking blood sugar readings which would help to personalise diabetes care and also as a real time news feed for information on developments in diabetes such as new blood sugar meters, stem cell research and the development of an artificial pancreas:

> ***P:*** *…Yeah. I guess a Twitter feed I suppose a general Twitter feed could also have stuff like, um I don't know like say, links to I guess if, I don't know if anyone, I'm not sure what, if anyone if like, I guess you keep an eye on stuff like technological stuff if there was like an article that you didn't have to pay for about something or like or just mention that there's been like a new type of meter like this come out...* **[T1-QOL-02]**

> ***P:*** *But you could, I would also probably…er…(thinks) in the event of an emergency I mean if someone could just tweet on there help what do I do so and so's got a nose bleed and she's diabetic or something like that you know...* **[T1-QOL-03]**

Feedback from both interviews and questionnaires concerning the prototype Apps is currently being analysed and collated. Once developed to the satisfaction of practitioners and interviewees, it is intended that the Apps will be handed over for pilot use within a clinical setting, with the users playing the key role in deciding whether any of them have the potential to be taken forward for use on a wider scale. Further work will then be able to be undertaken to evaluate the usability and any potential impacts on HRQOL as a result of the use of the prototype Apps developed.

CONCLUSION

The current and potential use of Web 2.0 applications and the emergence of new portable devices offer an exciting future for developing a wide variety of diabetes related resources aimed at practitioners and clients. Writing about concussion support, Ahmed and Pulman (2012) suggested that the increasing capability of mobile technology allied with the global population's desire to access health information and communal support groups online, showed mobile technology had a growing significance in disseminating best-practice information for a variety of conditions. However, care must be taken to ensure that any information provided through such devices was accurate, and that adapted forms of delivery (particularly Apps) took into consideration the specific needs of the individual. It also key that proactive practitioners start looking at the technology around them and seeing if they can apply it to their own practice rather than waiting for technologists to suggest what they could or should do with it. It is vitally important that theoretical concepts such as empathetic understanding, reflection of the lifeworld experiences of patients, thinking about ways of humanising healthcare and considering the patient voice are considered by clinicians and technological developers as innovative ways of finding out what patients would like to see developed for their own use and thinking about how they feel before and during the development process. Then utilising a cogent design approach – such as sociotechnical design - which is the most suitable method for providing a solution which is satisfactory to all parties. As an example, the implementation and use of touchscreen technology in GP surgeries to speed up the appointment booking process does not seem to have taken into account how some older patients might get confused and worried when using the system, an important area, which by asking them to have contributed to the design and testing of the system in its earliest phases, might have been uncovered by the developers pre-implementation. It is hoped that the current dissemination of this research project's progress will assist in highlighting a more patient-centric approach to the production of quality health based mobile applications which can be applied not only to diabetes but to other LTC as well. Additionally, providing an example of how patient education can be designed in an inventive new way which meets the needs of a particular patient group and values and encourages their input to assist in the creative process whilst at the same time conforming to clinical guidelines.

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Augmented reality and mobile learning: the state of the art

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ABSTRACT
In this paper, we examine the state of the art in augmented reality (AR) for mobile learning. Previous work in the field of mobile learning has included AR as a component of a wider toolkit for mobile learning but, to date, little has been done that discusses the phenomenon in detail or that examines its potential for learning, in a balanced fashion that identifies both positive and negative aspects of AR. We seek to provide a working definition of AR and examine how it is embedded within situated learning in outdoor settings. We also attempt to classify AR according to several key aspects (device/technology; mode of interaction; type of media involved; personal or shared experiences; if the experience is portable or static; and the learning activities/outcomes). We discuss the technical and pedagogical challenges presented by AR before looking at ways in which AR can be used for learning. Lastly, the paper looks ahead to what AR technologies may be on the horizon in the near future.

Author Keywords
Augmented reality, mobile learning, education, situated learning, technology enhanced reality, state of the art, taxonomy.

INTRODUCTION

Augmented reality (AR) is a growing phenomenon on mobile devices, reflected by the increase in mobile computing in recent years and the common ubiquity of Internet access across the world. The NMC Horizon Report for 2011 named augmented reality as the highest-rated topic by its Advisory Board, with widespread time-to-adoption being only two to three years (Johnson *et al.*, 2011). What was once seen by many as being a mere gimmick with few applications outside of training, marketing/PR or sport and entertainment, is now becoming more mainstream with real opportunities for it to be used for educational purposes.

This paper examines the state of the art in the application of augmented reality for education, with a particular focus on mobile learning that occurs in specific locations and outdoor settings. One of the most compelling affordances of AR is its resonance with immediate surroundings and the way in which information can be overlaid on top of these surroundings, enabling us not only to learn about our environment but also giving us the tools to annotate it.

The paper begins with a definition of what we mean by augmented reality, before then exploring the pedagogical theories that underpin AR. We offer a framework that can be used to classify AR in mobile learning, before examining the criticisms and limitations of AR. Lastly, we suggest how AR can be embedded within mobile learning. We make two important contributions to the field: firstly, a *discussion of the underlying pedagogies* surrounding the use of AR; and secondly the *taxonomy* that seeks to classify the different aspects of mobile AR for learning in outdoor situations.

DEFINING TECHNOLOGY ENHANCED REALITIES: VIRTUAL, MIXED AND AUGMENTED

Azuma (1997) defined AR as "*3-D virtual objects [...] integrated into a 3-D real environment in real time*" and this reflects the majority of early research into the use of AR as a primarily graphical display. However we consider this definition to be too narrow and instead prefer to consider a working definition of AR to include the fusion of any digital information within real world settings, i.e. being able to augment one's immediate surroundings with electronic data or information, in a variety of media formats that include not only visual/graphic media but also text, audio, video and haptic overlays. Indeed, in a later paper, Azuma *et al.* (2001) updated this earlier definition and reduced the emphasis on graphical objects, stating that the three essential properties of AR are the combination of virtual and real objects in a real environment; a system that aligns/registers virtual and real objects with each other; and that runs interactively in real time. They also mention 'mediated reality' or 'diminished reality', where real objects in the user's surroundings are electronically stripped out or removed, so the user is better able to focus on other aspects of their environment.

A critical aspect of AR is the *context* in which it is used: it is not just enough to state that AR is mere availability or presence of digital media within a particular location, as this could encompass a casual passer-by listening to music on their mp3 player as they travel through that environment. Rather, we need to take into account the *explicit intention* of this digital media, to supplement or augment our surroundings through additional information being made available (e.g. visually, auditory or through haptic interfaces) that has contextual relevance to that specific place.

Milgram *et al* (1994) provide a helpful visualisation to represent how reality and virtuality are connected (see Figure 1). It shows a continuum that encompasses all real and virtual objects and environments. Mixed reality is an area in the middle, where the two extremes meet, and is considered a blend of both the virtual and the real:

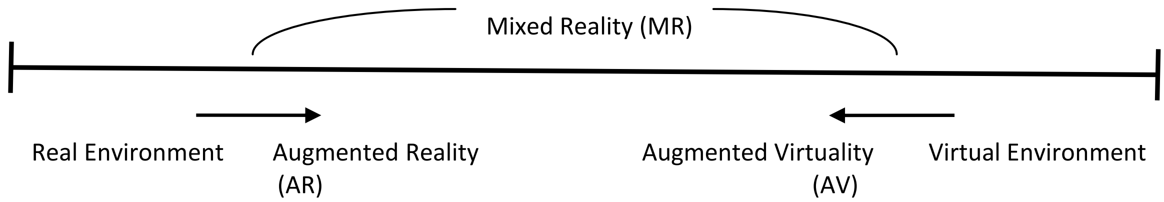

Figure 1: Representation of the Reality-Virtuality (RV) Continuum, re-drawn from Milgram *et al.*, 1994

Whilst it is clear that virtual, as well as real, environments can be augmented, this falls under the category of 'augmented virtuality' as shown in Figure 1 and as such is outside of the scope of this paper. Much interesting work has been done in the area of virtual worlds and education; however we are more concerned with how learning takes place in an augmented *real* world. We will also be focusing on the use of augmented reality for mobile learning, in all senses of the word 'mobile', where the learner is not constrained to a desktop PC at a fixed location and the learning itself may be dynamic and across contexts. Fixed or static AR can be seen more in large screen displays in public spaces or through desktop computers and can generally only be used in that one specific place. Mobile AR brings in new aspects: most importantly, it fosters the mobility of the user; their geographical position; the physical place where learning can occur (and also a means to bridge these different places); it can also enable formal learning to connect with informal learning. It also serves as a mechanism for more personal or individual experiences with AR, as shown later in Table 1, compared to a large static display that may be more suited to group experiences (such as those used for marketing or advertising). Spatial mobility is a powerful component in its own right, although it could also be combined with temporal mobility to bring AR to a new dimension, so learners can take advantage of AR resources 'on-the-fly', at a time and place convenient and relevant to them. Mobile AR enables us to integrate real-world experience and meaning within specific physical contexts.

In addition, most of the AR examples we discuss are located in outdoor environments; this is merely a reflection of the research in this area and is not an indication that AR should only be used outside, only that it seems compelling and easy to do so (possibly due to current technical limitations in indoor tracking/positioning, as a learner's location is often an integral aspect of the AR experience). In the past, technological limitations have sometimes confined both AR devices and their users to a fixed location; however developers have always aimed to make AR portable. When Sutherland began work on a three-dimension headset display in the 1960s, he noted that the fundamental idea behind such a display was "*to present the user with a perspective image which changes as he moves*" (Sutherland, 1968). Azuma (1997), considering the state of the art in AR, looked back on a decade of literature dealing with the medical, manufacturing, visualisation, path planning, entertainment and military applications of AR. His review suggests various learning opportunities implicit in this research, such as the opportunity for medical students to develop their understanding based on an X-ray view of the human body, or for trainee architects to see not only the structure of buildings, but also their underlying infrastructure. He identified factors that would be key to the mobility or portability of this technology; also the need for trackers or sensors that could support the accurate alignment of physical and virtual realities at a distance by providing greater input variety and bandwidth, higher accuracy and longer range.

The developments Azuma reported in 1997 focused mainly on adding visual information, but by the beginning of the twenty-first century, researchers were working on augmented reality for all senses, including hearing, touch and smell (Azuma *et al.*, 2001). Milgram and Kishino (1994) wrote of the possibilities for *auditory* augmented reality, mixing computer-generated signals with those from the immediate real-world environment; *haptic* augmented reality, incorporating artificially generated sensations of touch and pressure; and *vestibular* augmented reality, synthesising information about the forces of acceleration acting on its user. Possibilities for mobile applications were also increasing, as researchers worked to make use of situational awareness and geolocated information retrieval. For example, Columbia University's Mobile Augmented Reality System (MARS) combined a mobile computer and headset with a compass, inclinometer and GPS (Global Positioning Systems), allowing users to see representations of historical buildings in their original locations (Höllerer *et al.*, 1999).

Other examples include Robinson *et al.* (2008), who developed a point-to-select method for GPS and sensor-equipped mobile devices, allowing users to highlight locations of interest during a journey and to later view a report about these locations. Kanjo *et al.* (2008) developed 'MobGeoSen' software components using sensors in mobile devices for mobile data collection to monitor the local environment or record a persons' activities. Further research by Benford *et al*. (2004) has evaluated systems for location-based multi-player games, seeking to understand how *in situ* users share location information at a distance through comparing self-reporting and GPS readings. Finally Coulton *et al.*'s (2010) recent work combines the emergent activity of geocaching (an activity similar to a GPS-guided treasure hunt) with augmented reality.

Mobile learning research has long understood the importance of locational context and the objects found in that location, to the process of meaning-making (Clough, 2010; Leinhardt *et al.*, 2002) and over recent years the capabilities of location-aware technologies has dramatically increased. Combining GPS and digital compass technologies can provide a basic functionality for locating someone holding a device and computing their orientation within that environment.

Recent advancement in GPS and networks have now enabled location accuracy to within 5-10 metres for single-point receivers (Ordnance Survey, 2012); with carrier positioning accuracy (or 'survey grade GPS'), this can be improved to less than 1 centimetre. Larger, thinner and lighter touch-sensitive screens and advances in cameras and sensors also increase the potential for creating and viewing information anytime and anywhere. Combining these technologies has led to the recent emergence of mobile applications that utilise location sensing to provide users with relevant geo-referenced information. Smartphone apps, such as Wikitude and Layar, orient users to information about their surrounding area (e.g. approximate distance and direction to a point of interest). What these systems need now are appropriate visualisations (or other methods of feedback), representations and guidance to provide or enhance *situated* meaning-making.

AUGMENTED REALITY, SITUATED LEARNING AND EMBODIMENT

In order to gain insights into the unique learning affordances of mobile AR, we need to juxtapose it with mobile learning in 'normal' (and thus non-augmented) reality. But what is 'normal reality' mobile learning before we augment it and what does augmenting that reality provide us with? A focus on learning through interaction with 'reality' directs us to situated theories of learning, and a careful attention to context. Indeed, e-learning designers, developers and educators often lack clarity regarding the impact that a student's situation has on their interpretation of e-learning. Vygotsky argued that human consciousness is associated with the use of tools and artefacts, which mediate contact with the world. These tools produce quantitative improvements in terms of the speed and efficiency of human development; they also produce qualitative transformation because mediated contact with the world provides humans with the means to control and organise their behaviour rather than be buffeted by external stimuli (Vygotsky, 1978). Vygotsky's emphasis on the mediating role of artefacts introduces the material dimension of reality, or context, yet limits that to man-made objects, excluding the natural world. Arguably, any material object we interact with is artificial, in the sense that our perception of that object is shaped by culture and history. However, Bruner (1990) and Papert and Harel (1991) broaden the lens, and consider the child's development through exploratory interaction with the world around them and abstraction of their experiences.

Bowker and Star (2000) take the concept of 'situated' learning further by suggesting we must also consider issues of space and time in a learning process, although this could increase the potential for chaos. Latour (1999) in turn emphasises our need to create order in these processes and the increased likelihood of disorder elsewhere. Education, it could be argued, often involves widening the gap between these worlds before some resolution is made. Our 'reality' is therefore continually mediated and reinterpreted by our practices and meaning-making exercises in that reality. At a first glance, the shift from low-tech to mobile-tech and to AR may seem merely quantitative: augmenting, or rather *adding* to that reality has always been a part of education, whether it is through e.g. informative signposts placed at a geological site or tourist venue; costumed re-enactments of historical events; or a straightforward on-site tuition provided by a teacher or parent. We change our perspectives, understanding and meaning-making of that reality through augmenting it with additional educational information. Technology has merely given us systems and resources that can enhance our situated learning through augmenting our realities more effectively. Yet we need to consider how new technologies might offer the potential for qualitative change in our relationship with reality: imagine a learner leaving a 'video note' for her peers at a historical point of interest; viewing a geographical site as it would have looked in the ice age; or collecting audio-visual notes of her observations. Such experiences transform reality into a multi-modal social text, in the tradition of Bezemer and Kress (2008).

Embodied cognition can also provide us with a complementary framework, since AR affects the way we interact with the physical world. The bodily experiences that we engage with when we use AR, help us to construct meanings from our reality and include cultural and contextual factors, as well as social ones – hence cognition itself is embodied (Núñez *et al.*, 1999; Radford, 2005), providing a foundation for social situatedness. Barab *et al* also refer to 'situative embodiment' (Barab *et al.*, 2007) where the learner "*enters into a situation narratively and perceptually, has a goal, has a legitimate role, and engages in actions that have consequence*".

CLASSIFYING AUGMENTED REALITY: A SUGGESTED TAXONOMY

This section of the paper aims to produce an initial taxonomy of projects where AR has been used in mobile learning scenarios; a wider taxonomy could also include purpose/usage as a separate category, where education would be one example (others might include providing information; navigation; entertainment; social interaction; marketing/PR etc). However, for the purposes of this paper we focus on education, specifically mobile learning, examining first the different dimensions inherent in AR before exploring some of these in more detail through several case studies.

Table 1 shows the different dimensions used in six mobile learning projects that used augmented reality as a key component. The information displayed in this table shows how AR has been used mostly as a portable experience, but which lends itself to both personal and shared interactions. There were no incidences of larger, static displays or ones targeted at larger group experiences, both attributes which are exemplified in AR experiences such as video mapping (see e.g. work by the Macula project, such as 'old town' [http://vimeo.com/15749093], created to celebrate the 600 year anniversary of the astronomical tower clock situated at Old Town Square in centre of Prague). This may suggest that the current use of AR in mobile learning is generally geared towards individual (or small group) experiences.

Project (in date order)	Device or technology used	Mode of interaction	Method of sensory feedback to the user	Personal or shared experience	Fixed/static or portable experience	Learning activities or outcomes
Zapp (Meek *et al.*, 2012)	Smartphone	Passive/assimilative (information layer) + active/exploratory (data logging/querying tool)	Visual overlay: label/text	Both personal and shared (small groups)	Portable	Interpreting the geological features of a rural landscape through situated inquiry and collaboration
Out There, In Here (Adams *et al.*, 2011)	Laptops, tablet devices, smartphones	Passive/assimilative (information layer) + exploratory	Mixed: visual; auditory; text	Shared (small groups)	Portable	Collaborative inquiry-based learning, to enable sharing of data; development of hypotheses; access to information/resources etc. between in-field students and those indoors in a lab
CONTSENS (Cook, 2010)	PDA (Personal Digital Assistant); mobile phones	Constructionist (AR-based modelling)	Mixed: visual (3D wireframe model); video	Both personal and shared between 2 users	Portable	Archaeological and architectural surveying of the ruins of an abbey; specifically, providing different visual perspectives on the mobile devices
Augmenting the Visitor Experience (Priestnall *et al.*, 2010)	PDAs; mobile phones; tablet devices; head-up display (HUD)	Passive/assimilative (information layer) + active/exploratory	Mixed: visual, audio, text, video	Both personal and shared between 2-3 users	Both static and portable	Comparing different technologies/techniques to provide information about the landscape to the casual visitor; student-generated criteria focused upon usability and sustainability
History Unwired (Epstein and Vergani, 2006)	Smartphones, PDAs (Pocket PC) + headphones	Passive/assimilative (information layer) + active/exploratory	Mixed: audio, video	Both personal and shared	Portable	Informal learning about the Castello region of Venice, via a walking tour that uses local citizens to depict a local experiences of art and craft, history and folklore, public and private spaces
Mudlarking in Deptford (Futurelab, 2006)	PDAs + headphones	Passive/assimilative (information layer) + active/exploratory	Mixed: text; audio; visual	Shared (small groups + pairs)	Portable	Students acted as co-designers to help create local tour guides on mobile devices, using multimedia relating to the local area and their own observations

Table 1. A suggested taxonomy of AR used in mobile learning projects, showing how it can be used to categorise different aspects of the research

The modes of interaction have generally focused around either providing passive information overlays to the learner, depending on their physical location or movements/gestures, or engaging the learner in an exploratory mode where they are encouraged to actively discover or create/log media nearby in order to e.g. solve a problem or meet characters from a story. More modes of interaction may evolve in the future although some, such as the ‘constructionist’ mode, may be more relevant to specific knowledge domains (e.g. architecture or structural engineering). The ‘active/exploratory’ mode is also akin to AR games such as Environmental Detectives (Klopfer and Squire, 2008), although we have concentrated on non-gaming examples here as this is another research area in its own right.

The media used has primarily been a mixture of visual (still images), video, audio and text, although the ‘Augmenting the Visitor Experience’ project also used a non-digital format, that of printed acetates showing an outline of the landscape at fixed viewpoints with written annotations/labels. Whilst this is not strictly AR, according to our earlier definitions, it nevertheless presents an interesting vision for the future, as its transparent properties mean that information can be overlaid whilst the user is still able to literally see beyond the augmentation and still perceive the landscape behind it. This property is being exploited by Google with their ‘Google Glass’ product, that is discussed later in this paper. It is interesting to see how the nature of the device or technology used for engaging with AR has also changed; early projects tended towards the use of PDAs and mobile phones, whereas more recent projects are, not surprisingly, utilising smartphones and tablet devices. What is exciting is how personal smartphones contain an increasingly sophisticated array of sensors, thus enabling AR to become more personally meaningful and situated, so that what was once the domain of a researcher intervention loaning specialist equipment for a short user trial, is now much more likely to be accessible by the students or the general public on an everyday basis, thus providing a more sustainable technology for everyday learning.

CRITICISMS AND LIMITATIONS OF AUGMENTED REALITY

Although AR as a technology has evolved much over the last decade, there remain some challenges and limitations around the use of AR in educational situations. These can be broadly divided into technical challenges and pedagogical challenges.

Technical challenges

While high cost, fragile geolocation systems can measure to centimetre accuracy, handheld mobile tools accessible to the wider educational sphere can only measure to several metres accuracy (e.g. handheld GPS receivers, or mobile devices containing such). The accuracy of such devices can be further degrade by local environmental conditions, such as 'urban canyons', where tall buildings create shadowing and reflecting of signals to further lower the ability of a student to pinpoint their position. Practically, this means that educational settings can only expect accuracy to within ten metres: suitable for standing on top of a mountain and surveying a large area, but not to distinguish one side of a street from another (Gaved *et al.*, 2010). A lack of accuracy in pinpointing a student's position may lead to registration errors, where an AR device or app, retrieving data from a recorded set to match what it thinks is the device's present location, may present wrong information to the student as it is unable to correctly calculate its exact position.

AR typically requires some form of internet access. Devices using phone networks will be susceptible to varying quality of signal: while basic phone and 2G networks may be reliable in urban areas in developed countries, rural and less developed locations may have less reliable signal quality. Additionally, 3G and other higher data rate services cannot be assured: for example, there is greater 3G phone coverage by area in the seas off Scotland, than on the actual mainland of Scotland (Ofcom, 2009). Alternative strategies, such as setting up your own local network, may have to be considered if reliable network access is required for the tools to function (Davies *et al.*, 2010).

In common with other mobile technological tools, the student and tutor have to maintain the overhead required for the devices to function: battery life may become an issue, as can finding locations where good radio signals can be picked up. Other concerns include ensuring the screen can be read in bright sunlight and ensuring the device can function in rain, or after being dropped.

Pedagogical challenges

AR can present many pedagogical issues in common with other technological additions to learning and teaching. One criticism of AR is the concern that learning may not be driven by the pedagogy but more by the AR tools' strengths and weaknesses.

For example, the novelty of the technology may detract from the learning experience (e.g. students focussing on shiny new devices rather than their learning objectives). The technology may also guide how and where the learning occurs and it is important to make sure the learning is not altered to fit around the device's limitations (e.g. do students need to work where there is a shaded area so they can see the screen, rather than standing in the best place to understand the context; do educators need to factor in extra time to change batteries and hence there is a reduction in the amount of time spent actually being physically in location). There may also be a need for additional technical support if the AR is not easy to use and install.

There is also the problem of the technology being more engaging than the surrounding environment and instead of making the most of being at a particular location, students' attention is inappropriately focused on the AR devices and tools. In this situation, it is important to consider if the technology actually removes the students from the immediate experience of the location rather than augmenting it.

From a teaching perspective, it is also critical to consider first what are the learning objectives and goals that a tutor or educator wants their students to achieve, before considering how best to achieve these. It may be that AR is not the best method to employ and that other, cheaper, more robust techniques are much more appropriate to the learning activity that is taking place. Additionally, providing an immediate overlay of labels on e.g. geographic/architectural features could possibly lead to a detriment in developing observation skills through excessive scaffolding and reinforcing. In this situation, it may be better to offer a more staged approach where AR is offered as an add-on, once students have acquired a certain level of proficiency in interpreting their environment without needing the use of such tools.

EMBEDDING AUGMENTED REALITY IN MOBILE LEARNING: PRESENT AND FUTURE

It is clear that there are both opportunities and challenges in integrating AR into mobile learning; however we remain convinced that there is something very compelling in doing so. Studies have shown that using AR for educational purposes can appeal to students at a much more personal level, promoting both engagement and motivation amongst its users (Klopfer and Squire, 2008; Luckin and Stanton Fraser, 2011). A recent study where AR was used in a static environment, using desktop computers both at school and home, showed that AR supported particular learning activities, such as problem solving, in a highly interactive and memorable fashion (Luckin and Stanton Fraser, 2011). This last study also referred to other positive aspects of AR found within its research, such as its ease of use amongst young children; its enjoyment/"fun" factor; its flexibility (in terms of using it with a range of age groups or across different subject domains); the ease of use in reference to installation/mobility of hardware; and the immersive and engaging nature of three-dimensional AR visualisations (Luckin and Stanton Fraser, 2011).

Several projects have focused on the way in which AR can be used to encourage problem solving and independent research amongst learners. For example, Squire (2010) notes that "*from a classroom management perspective, the narrative elements of the unit enabled teachers to create a dramatically different classroom culture, one that was built around students performing as scientists. ... Most noteworthy to teachers was how the technology-enhanced curriculum enacted students' identities as problem solvers and knowledge builders rather than as compliant consumers of information…*". The idea of learners engaging in collaborative problem solving has also been examined by Cook and his work on Augmented Contexts for Development (ACD) (Cook, 2010) that extends the original Vygotskyian concept of Zones of Proximal Development (ZPD) (Vygotsky, 1978). Cook suggests that mobile devices and their surrounding physical environment enable learners to generate their own contexts for development, which can be interpreted or assisted through AR. From the analysis of a video blog recorded by students on an architecture field trip, it seems that students used physical and digital representations to synchronously interact and inform one other, leading to a co-constructed knowledge that formed as a result of the interaction of the learners with the AR tools and media. In this respect, the mobile devices acted as contextual sensors, enabling particular visualisations to be portrayed to the learners in a situated manner. Another example of how situated visualisations and mobile connectivity to larger processors and server infrastructure can enable learning can be seen through translational overlays of AR, when viewing a foreign language text through e.g. smartphone apps.

Another way in which AR can be used to support learning is through haptic interfaces, particularly when used with blind or visually-impaired users. The 'Haptic Lotus' used a handheld plastic flower that contained embedded sensors that responded to its user position in an indoor gallery by opening its petals and delivering haptic feedback, and was used as a way of encouraging exploration whilst also providing reassurance of the nearby environment for both sighted and blind people(van der Linden *et al.*, 2012). Mehigan (2009) also discusses the use of sensors in smartphones – particularly accelerometers – to develop opportunities for mobile learning for vision-impaired students and also reduce the 'digital divide' that exists between sighted and blind students. Audio may also be a valuable AR tool here: for example, a sound-rendering system can transform the visual data of objects and places into auditory information, overcoming a major difficulty currently experienced by visually impaired learners. In addition, being able to integrate visual labels and audio tracks into learning environments offers teaching opportunities for all learners and may be particularly helpful for pupils with learning difficulties, whose cognitive abilities may not allow them to visualise abstract or hidden parts of systems (Lin *et al.*, 2012). Sprake also talks about haptic referencing as a means of connecting more fully with our local surroundings (Sprake, 2012).

The use of haptic referencing and the notion that embodiment in mobile learning can be facilitated by AR is an intriguing one. Becket and Morris (2001) argue that learning has become disconnected both physically and conceptually from the student and that educational research must return to the physicality of the students' bodies for two reasons: firstly, the growth of the corporatized virtual university (and thus a diminished importance attached to a physical place of study by corporate managers); and secondly the commoditisation and packaging of learning (digital content is placed online and "left to die" in a VLE - see timbuckteeth, 2011). Mobile learning where learning is situated, or *embodied* in a particular reality, which is itself augmented, could help to counteract these problems.

In the last decade, augmented reality has progressed from a specialist, relatively expensive technology to one that is now commonly available to the general public, due to technological advances in mobile computing and sensor integration. Although it could be argued that AR has yet to become completely mainstream, smartphone apps such as Layar and Wikitude mean that its adoption and use is becoming increasingly commonplace. Large corporations such as Google have shown its commitment in developing AR technology, e.g. through the Google Goggles product (visual recognition of landmarks in photos taken by e.g. a smartphone camera and subsequently overlaying relevant information) and more recently the Google Project Glass, a proposed 'heads-up display' that will overlay contextual information on top of clear transparent glass, through e.g. AR spectacles (Eddy, 2012). EyeTap uses a similar premise to Project Glass, with the device worn in front of the eye like a pair of conventional glasses, that can record what the wearer is seeing but also superimpose computer-generated imagery on top of their normal physical world (see http://eyetap.org for details).

One use of AR that will increasingly become available and promoted through Higher Education institutions builds on the campus map and providing navigation for newcomers (the 'augmented campus', see e.g. Genco *et al.*, 2005), as well as linking in with friendship circles to arrange common meet-up times and locations. This extends prior experiences of the use of mobile devices for more immediate use of 'dead time' (Pettit and Kukulska-Hulme, 2007). While this has previously been managed through plan views and mapping tied with social networks, overlays are increasingly used to convey this information, as can be seen by the recent advent of Blackboard Mobile Central AR features (Blackboard, 2012).

SUMMARY

We have presented what we consider to be the current state of the art of augmented reality for mobile learning. We have discussed the theoretical underpinning of AR in relation to situated learning and created a taxonomy of AR mobile learning projects as an interesting way of analysing current trends and exploring the potential for future development. We have also discussed the limitations and challenges inherent in the application of AR for mobile learning experiences, as well as offering some suggestions of how AR can enhance learning and how it might be used by students and educators.

The use of AR in education, and particularly mobile learning, is still in its infancy and it remains to be seen how useful it is for creating effective learning experiences. From examining the learning activities shown in Table 1, it is clear that AR can be used very successfully for situated and constructivist learning, particular where collaboration and student inquiry form key aspects. It can also be used for informal learning and more touristic experiences.

We hope to revisit this work in another few years and report on new innovations and the way in which they have been adopted (or not) by the learning community. What is clear is that we currently have the opportunity to provide immersive, compelling and engaging learning experiences through augmented reality, which are situated in real world contexts and can provide a unique and personal way of making sense of the world around us. We believe this is a powerful tool, provided we can harness it appropriately, and look forward to seeing how other academics and practitioners advance this research field further.

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Learning Analytics in Mobile and Ubiquitous Learning Environments

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ABSTRACT
Learning analytics (LA) is one of the promising techniques that has been developed in recent times to effectively utilise the astonishing volume of student data available in higher education. Despite many difficulties in its widespread implementation, it has proved to be a very useful way to support failing learners. An important feature of the literature review of LA is that LA has not provided a significant benefit in terms of learner mobility to date since not much research has been carried out to determine the importance of LA in facilitating or enhancing the learning experience of mobile learners. Therefore, this paper describes the potential advantages of using LA techniques to enhance learning in mobile and ubiquitous learning environments from a theoretical perspective. Furthermore, we describe our simplified Mobile and Ubiquitous Learning Analytics Model (MULAM) for analysing mobile learners' data which is based on Campbell and Oblinger's five-step model of learning analytics. Finally, we answer the question why now might be the most suitable time to consider analysing mobile learners' data.

Author Keywords
Mobile learning , M-learning , Ubiquitous learning , U-learning , Learning Analytics , Mobile Learning Analytics , MLA, Ubiquitous Learning Analytics, ULA.

INTRODUCTION

The wide range of available mobile and communications technology options plays a vital role in extending the use of mobile devices for different purposes instead of merely functioning as phones to make calls and send text messages. More importantly, these different technologies are compatible with almost all handheld devices. This technological facilitation has encouraged educators to utilise mobile technology in education as an instructional tool for learning, which is widely known as mobile learning or m-learning. In addition, it has also encouraged the implementation of ubiquitous computing in education. For example, it provides learners with the context-based learning materials to help them build their own knowledge based on their context and to share it easily with others, without the constraints or limitations of time and place. This is referred to as ubiquitous learning (u-learning) or pervasive learning (p-learning).

Educators who incorporate mobile devices into their learning strategies would derive great benefit from this unprecedented opportunity to engage learners since access to the internet via mobile phones is increasing at a rapid rate. A recent survey found that the percentage of mobile users who access the internet via their mobile devices in the UK is 59%[1], whereas in both the US[2] and Saudi Arabia[3], the percentage of users is 66%. It has been observed that the number of mobile users is continuously increasing; it is estimated that there are over five billion mobile subscriptions around the world (ITU, 2011). Moreover, by 2015, it is estimated that 80% of people will access the internet using their mobile devices (Johnson, Smith, Willis, Levine, & Haywood, 2011). The increasing number of mobile users might play a key role in increasing the volume of data that is produced. A study conducted by the IDC (2008) on the existing volume of digital data found that the rapidly expanding 'digital universe' was expected to grow to 1.2 million PB, or 1.2 zettabytes (ZB), by 2010 and to reach 35 ZB by 2020 (Reinsel et al., 2007).

With the current deluge of data from disparate sources, the potential exists for analytics to increase the value of such data and the understanding of the situations involved. This leads to speculation regarding the sorts of questions that could be answered by analytics. According to the matrix developed by Davenport et al. (2010), six questions can be answered through the effective use of data and analytics, and answering these questions might help many organisations to address many of their problems (see Table 1). The questions are

[1] http://www.thinkwithgoogle.com/insights/library/studies/our-mobile-planet-United-Kingdom/
[2] http://www.thinkwithgoogle.com/insights/library/studies/our-mobile-planet-us/
[3] http://www.thinkwithgoogle.com/insights/library/studies/our-mobile-planet-Saudi-Arabia/

divided into two groups. The first group concentrates on the effective use of the data. The 'past' information cell reports to the organisation what happened in the past, but it does not involve any analytics. However, by applying the rule of thumb, the organisation can generate alerts in the present. In addition, through the exploration of past patterns, it is possible to create some assumptions about the future. The first group of questions provides informative reports about what is happening rather than why something occurs or how it may recur in the future.

The second group of questions requires advanced analytical tools and methods to carry out comprehensive investigations in order to gather new insights. Using some statistical models and tools, it is possible to gain an insight into the past and thereby highlight possible factors that caused a past occurrence. In addition, it is possible to gain real-time insights which in turn can help an organisation to understand what is happening at the present time and can assist in the formation of recommendations to ameliorate the situation. Finally, future insights can be attained by adhering to predetermined optimisation and simulation techniques that assist in understanding both the past and the present and thereby enable predictions with respect to possible future results. Indeed, the optimal use of data can play an important role in increasing understanding of the past, present and future, improve the accuracy of this understanding and enable smarter decision-making.

	Past	***Present***	***Future***
Information	What happened? (Reporting)	What is happening now? (Alert)	What will happen? (Extrapolation)
Insight	How and did it happen? (modeling, experimental design)	What's the next best action? (recommendation)	What's the best/worst that can happen? (prediction, optimisation, simulation)

Table 1: Key questions addressed by analytics (Davenport et al., 2010)

The move towards using data to make decisions has been considered in many domains, such as business and medicine, which reflects the value of analytics. In education, analytics is of great importance since it can assist in solving many educational problems, such as student engagement which is anticipated to emerge as a problem owing to the growing complexity and sophistication of higher education research, practice and policy. The issue of student engagement is becoming ever more critical, as it is a process that might enable educators to indicate students' attitudes towards universities and their academic and non-academic activities. Moreover, student engagement identifies the nature of the relationships that exist between students, academics, university resources and academia in general. Identifying these relationships might help to provide insights into the relationship between student engagement and their academic achievement, and the potential for improvement. Consequentially, measuring levels of engagement is of particular importance. It is in light of this issue that the application of analytics could prove to be very useful (Beer, Clark, & Jones, 2010).

For educators, having the ability to analyse the learning activities of mobile learners is likely to be of great value. In the mobile environment, learning materials can be accessed on the move, and the learner does not need to be fixed in one location. Learning on the move requires an understanding of the pattern of communication of learners among themselves and the patterns of the interaction between students and their learning materials. However, in the literature of LA, it is clear that there have been many efforts to make use of non-mobile students' data that is retrieved from different university systems. However, the issue of mobile learners' data has not been addressed sufficiently, and to date only limited research has been conducted in this area. As a result of this gap in the literature, this paper will describe the possible impact of LA on the mobile and ubiquitous learning environment from a theoretical perspective.

This paper is organised as follows: Section 2 briefly describes the concept of learning and academic analytics while Section 3 justifies the significance of Mobile Learning Analytics (MLA). Section 4 discusses the value of Ubiquitous Learning Analytics (ULA) by presenting two possible kinds of learner interaction with computers. In Section 5, we present our suggested MULAM analytical models. Section 6 answers the question why now might be the most suitable time to consider analysing mobile learners' data. Section 7 concludes the paper.

LEARNING AND ACADEMIC ANALYTICS

Higher education is a field where records provide an astonishing amount of data about its participants, such as students and teachers, its facilities and curricula (Campbell & Oblinger, 2007; George Siemens & Phil Long, 2011). With the wide utilisation of communication technologies in learning, the amounts of data about students and their learning activities are accumulating at a rapid pace. Consequently, this utilisation of technologies has played an important role in opening new and unprecedented windows of opportunity to use this available data to measure the students' levels of engagement quantitatively (Beer, Clark, & Jones, 2010), to identify those students who are at risk, assess their progress and help them before it is too late (Barber & Sharkey, 2012), evaluate student dropout rates and improve the rate of student retentions (Lauría, Baron, Devireddy, Sundararaju, & Jayaprakash, 2012). Learning and academic analytics are tow concepts introduced which clarified how students' data might be used and analysed. This section briefly describes the concept of learning analytics and academic analytics along with the difference between them.

LA has been introduced to examine the potential of analytics to improve students' learning. According to 1st International Conference on Learning Analytics and Knowledge[4] , LA is defined as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs". The focus of learning analytics is on the learners and their academic performance. The data about their academic performance or their learning behaviour can be collected from different resources, such as their interaction with university learning systems. The main goal of this analysis is to identify the learners who might be struggling academically as early as possible, to allow for implementing some early intervention strategies that might help such students to succeed. Johnson, Smith, Willis, Levine, & Haywood (2011) stated that, "The larger promise of learning analytics, however, is that when correctly applied and interpreted, it will enable faculty to more precisely identify student learning needs and tailor instruction appropriately". It is clear that learning analytics focus more on the learning process, which mainly involves students, teachers and learning materials.

The term academic analytics was firstly introduced by Goldstein and and Katz: "the term academic analytics is our imperfect equivalent for business intelligence. We use it to describe the intersection of technology, information, management culture, and the application of information to manage the academic enterprise" (Goldstein and Katz, 2005) .There are many different opinions about what academic analytics means. For instance , (Arnold, 2010) reports that "Academic analytics helps address the public's desire for institutional accountability with regard to student success, given the widespread concern over the cost of higher education and the difficult economic and budgetary conditions prevailing worldwide.". In addition, some researchers consider academic analytics as a new way of applying business intelligence in an academic setting to provide data with the emphasis being on institutional, regional, and international levels (George Siemens and Phil Long, 2011). In addition, it was stated that "analytics marries large data sets, statistical techniques, and predictive modelling. It could be thought as the practice of mining institutional data to produce actionable intelligence" (John P. Campbell, 2007).

Generally, the focus of the academic analytics is on the institutional data which can be used at the administrative level, which in turn helps build a better understanding that can be used to determine the prospective universities' educational and administration strategies, for example. It helps in building a predictive model which allows admissions offices for example to know what to expect in terms of the size and composition of a prospective entering class. It is worthy of note that administrative departments, such as admissions and fundraising are believed to be the most common users and beneficiaries of analytics in higher education today (George Siemens and Phil Long, 2011). To summarize the main difference between them , it can be said that academic analytics clarifies the role of data analytics at the institutional, administrative and policy making levels. The scope of learning analytics on the other hand is not as broad as academic analytics as it focuses more on the role of data analytics at the learning process level.

There are many successful examples that show the role of analysing the students' data in enhancing their learning. For instance, Macfadyen & Dawson (2010) developed an early warning system, which revealed the relationship between the students' online participation and their academic status. One of the more well-known examples of how student data has been used to enhance learning is the 'Course Signals' application, which was developed at Purdue University. Course Signals is a student success system that identifies academic and behavioural issues early and notifies students and instructors in sufficient time that a recommended course of action can be provided to help students achieve their full potential in a course and also help minimise course failure (Arnold, 2010).

MOBILE LEARNING ANALYTICS (MLA)

MLA focuses mainly on the collection, analysis and reporting of the data of mobile learners, which can be collected from the mobile interactions between learners, mobile devices and available learning materials; it is also supported by the preregistered data about learners in different university systems.

In mobile learning environment, the nature of interaction between learner and mobile device takes the explicit form of interactions (Aljohani, Davis, & Loke, 2012). Based on this form of explicit interaction, the role of

[4] https://tekri.athabascau.ca/analytics/

MLA might be realized by analysing the mobile learners' data resulted in tow main interactions activities. The first one is the interaction between learner and available learning materials; this is called Explicit Learner-to-Learning Materials Interaction. Second, the interaction among learners, this is called here Explicit Learner-to Learner Interaction.

Explicit Learner-to Learner Interaction

Learning on the move is the foundation of the mobile learning environment. Since learners are not required to remain in a specific location, learning activities can occur without the normal physical constraints and greater learning flexibility is possible. Thus the learning interaction with learners can take place as long as learners carry their mobile devices. MLA can assist in developing knowledge regarding the way in which explicit mobile interactions with learners might improve learning. Analysing mobile learners' data generated as a result of this explicit interaction between students might provide useful information and lead to an understanding of the pattern of interaction between learners. Beyond the mobile learning environment, a useful tool known as Social Networks Adapting Pedagogical Practice (SNAPP) provides a visual representation of the interaction between students in relation to their activities on discussion forums. It enables teachers to identify which students are participating in discussions. SNAPP also illustrates comprehensively how interactions between students can be analysed (Dawson, Bakharia, &Heathcote, 2010).

Explicit Learner-to-Learning Materials Interaction

MLA might offer teachers the opportunity to understand the pattern of the explicit interactions between mobile learners and their learning material. One of the advantages of utilising MLA in the mobile learning environment is the possibility of evaluating whether the interaction between the learner and their learning materials is proving successful in the achievement of the designated learning objectives. In this context, mobile devices are used by learners to specifically study certain topics. The utilisation of MLA may provide a greater understanding of the efficacy and the quality of the learning process as it occurs in the interactions between learners, the educator and the curriculum. MLA may also offer the possibility of developing learning in the mobile environment through an analysis of the time spent by learners on specific activities, their preferred learning styles, their preferred learning times and the frequency of their access. This could allow for the provision of more customised learning materials for learners. Moreover, educators and students may acquire better knowledge of academic progress. Zoodles [5] is a good example of the value of implementing MLA. Zoodles has many features which provide a safe learning environment for young learners. The most important feature in the context of this paper is the dashboard which shows parents the learning activities that children have completed based for each subject, e.g. maths, reading, science, along with snapshot of their sketching.

UBIQUITOUS LEARNING ANALYTICS (ULA)

Following the development of sensing technologies it is now more possible to attain contextual data, such as times and locations, regarding the learners' use of various technologies, for example WiFI, GPS and RFID. This is the most significant aspect which distinguishes the ubiquitous learning environment from the mobile learning environment. The use of learner contextual data can assist in enhancing the interaction between learners, mobile devices and learning environments. The ubiquitous learning application retrieves contextual data about learners to improve the interaction between the mobile device and learner. The necessary learning materials are then provided to the learner implicitly based on the collected contextual information, allowing the learner to interact explicitly. The required contextual data is retrieved on an on-going basis to facilitate the explicit interaction through mobile devices (Aljohani, Davis, & Loke, 2012). Collecting the contextual data in this environment is useful in assisting learners to concentrate more on necessary tasks and allows for time to be saved on considering how a task can be performed.

ULA is concerned with the retrieval, analysis and reporting of the data of mobile learners along with their contextual information. This data might be retrieved from the mobile interactions between learners, mobile, learning environments and the provided context-based learning materials. This can be supplemented by existing data regarding learners from different university systems.

The effectiveness of this environment is derived from the utilisation of integrated sensing technologies of modern mobile devices. However, even though this is the case, little research has been carried out regarding the potential of LA in this learning environment. The implantation of ULA in this environment could offer a better understanding of the manner in which learning occurs in this heterogeneous learning environment. This could provide a good insight into the different requirements of each learner. Moreover, this might be of significant value in developing more functional educational software which would be more effective to deal

[5] http://www.zoodles.com/en/home/marketing

with the special features of the ubiquitous learning environment. In this section, the value of ULA is discussed by considering two possible kinds of interactions. The first is the interaction between learners and their contexts, referred to as Implicit Learners-to-Context Interaction. The second is the interaction between learners and context-based learning materials, referred to as Implicit/Explicit Learner-to-Context-Based Learning Materials Interaction.

Implicit Learners-to-Context Interaction

Analysing implicit contextual information has the potential to improve knowledge of the patterns of interactions of students with their context. The contextual information about a learner, e.g. location and time, is collected automatically by the mobile application using different sensing technologies, e.g. RFID, GPS and WiFi. The collection of this contextual information does not necessarily require any direct intervention from learners, however the use of such data could make learning more effective. For instance, the System for Capturing and Reminding of Learning Log (SCROLL) is an ubiquitous learning log system which has been developed by Mengmeng, Ogata, Bin, Uosaki and Yano (2012). This system can be considered as a good example of the potential that analysing the interactions between learners and their context provides. SCROLL utilises past retrieved collected contextual data about learners which in turn offers learners the potential to benefit from the context-based logs: when learners are in the place where the log was written, it can assist them in remembering what they learnt.

The RunKeeper[6] mobile application is also a good example of the successful utilisation of the analysis of the implicit interaction between a user and their collected contextual data, however this example is not derived from within the formal learning environment. RunKeeper utilises GPS to track the running locations of its users which is thus considered to be implicit collected contextual information. This data allows RunKeeper to provide users with, for example, the opportunity to track their fitness or health history. These statistics are displayed to users on their personal dashboard which can be accessed using their mobile. Most importantly, by analysing the users' collected location information, RunKeeper allows users to compare workout information from the locations they have visited. Also, it provides users with the ability to share fitness and health data with other users in their network.

Implicit/Explicit Learner-to-Context-Based Learning Materials Interaction

The collection of contextual information on learners has facilitated the enhancement of learning, especially in outdoor activities (Hui-Chun & Gwo-Jen, 2010; Shu-Chen et al., 2010). This can helps learners to concentrate more on learning and the relevant material. However, in certain cases, further research and analysis into the interaction between learners and provided context-based learning materials is required. ULA could help develop an understanding of the patterns of interaction between learning and the context-based learning materials. The potential use of ULA might depend on the collection of data and suitable analysis of the interactions between learners and context-based learning materials. ULA could be used with the assistance of analytical methods such as data mining and social network analysis, providing further understanding of learner and context-based learning materials interaction. The ULA report may provide details such as the amount of time spent on learning, preferred contextual objects for interaction, preferred times of context-based learning and learning styles. This information would help to categorise students with similar learning features and needs. Additionally, it could help identify those learners who are not participating effectively on learning to a desired standard. The collection of the aforementioned information in this section might be of great use in tracking the progress of learners and assisting them effectively during the learning experience.

MOBILE AND UBIQUITOUS LEARNING ANALYTICS MODEL (MULAM)

There are many suggested models for learning analytics, one of which is the Campbell and Oblinger five-step model of learning analytics namely Capture, Report, Predict, Act and Refine (Campbell & Oblinger, 2007). This model provides a useful understanding of how learning analytics can be applied. In the spirit of this model, we propose our simplified model, which will be followed in our investigation in the m-learning and p-learning environments (see Figure 1).

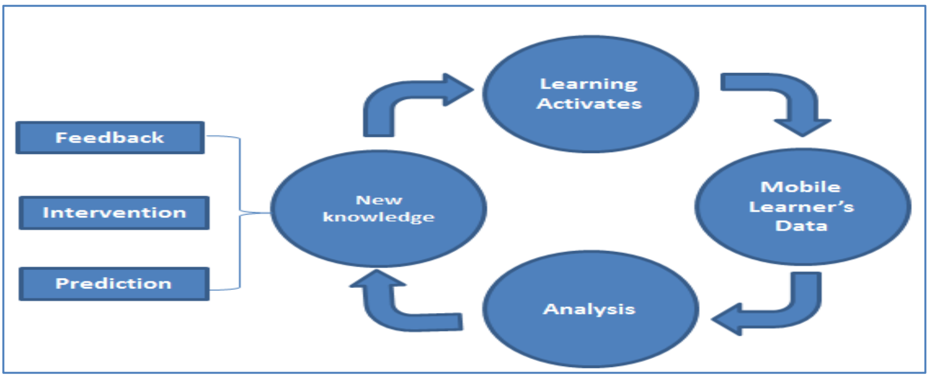

Figure 1: Mobile and Ubiquitous Learning Analytics Model (MULAM)

Learning Activities

The model starts with the specification of the learning activities as the core requirement that needs to be understood before conducting the analytics. Specifying the targeted learning activities plays a key role in increasing the accuracy of the collected data, meaning that it helps to answer the question, “which data could provide useful insights” (Campbell & Oblinger, 2007). In addition, specifying the learning activities might limit the number of required data which might turns to decrease the degree of seriousness or the challenges of analytics.

Mobile Learners’ Data

Upon successfully specifying the learning objectives of the learning activities, the needed learners’ data can be collected. In the literature, it is noticeable that some of the LA research has collected a high volume of data from different systems; however, a large portion of this data was not used as it was not relevant to the investigation.

Analysis

The analysis of data is the most important step and helps to make sense of the collected data and to make sure that the planned learning objectives of the specific learning activities have been met. Furthermore, it provides an insight into the learning difficulties that students might suffer from in the early stages, which will give the teacher the information needed to assist students before it is too late. There are many methods of analysing the collected data; these are generally based on the desirable outcome and how fast this outcome is needed. For instance, it can be done using statistical methods such as mean, standard deviation. In addition, data mining techniques can be used; data mining has two famous objectives, which are predictive and descriptive objectives. The predictive objectives of data mining, such as classification and regression, can be achieved using part of the available variables to predict one or more of the other variables. On the other hand, the descriptive objectives of data mining, such as clustering and association rule discovery, can be achieved by identifying the patterns that describe the data. This approach has the advantage of being easily understood by the user (Han, Kamber, & Pei, 2011). Analysis can also be done by using the social network analysis methods in which the interactions between students can be understood (Siemens & Baker, 2012).

New Knowledge

Upon successful completion of the analysis phase, it is likely that new knowledge or tacit knowledge will be found. Based on our model, this new knowledge can be used in three ways. First, it can be fed back to the learners in their personal dashboard, which will serve to increase their awareness of their performance, especially if there is a comparison between each student’s academic achievement with his/her peers. Second, it can be used to develop suitable intervention strategies that can be applied to solving the learning problems that have been encountered. Third, the new knowledge helps in building a predictive model, which, for example, allows teachers to know what to expect in terms of the number of students who might be able to complete the class or might leave. These three ways can be used separately, or together.

THE RIGHT TIME FOR MLA AND ULA

The present is the best time to introduce MLA and ULA in order to enhance academic achievements as well as solve the academic problems that students might face. Firstly, as previously mentioned, there has been a noticeable increase in the number of mobile users. In addition and most importantly, there is clear technical support for the building of applications for handheld devices. Building applications for small devices used to be constrained by small file sizes, low memory, display and power capacity. However, currently, there are many programming languages and technologies which play a key role in increasing the possibility of creating applications for constrained devices. These programming languages take into consideration the obstacles from which small devices suffer. This section reviews a selection of these promising technologies that support application building for mobile devices. It is important to clarify the difference between native and mobile web applications as a contextual prelude to a discussion in this regard. A native mobile application is an application that has been developed using a specific language to be utilised on a specific platform. For instance, the iPhone platform requires the mobile application to be written in objective C programming language. However, mobile web applications have not been developed to work in specific mobile devices.

Html 5 support

The continuous improvement of HTML5 open new windows of opportunity to build a mobile application that can be used across all platforms and plays a key role in overcoming the problem of platform dependency. This was not possible a few years ago; it was difficult to develop mobile applications that worked across all platforms. Even though some might prefer a native application as it makes use of all available device features, HTML5 holds great potential for the future of learning through mobile devices (Levy, 2011).

jQuery Mobile
It is HTML5-based user interface system .It provides broad level of support for the design of interfaces for different mobile platforms and therefore plays a role in overcoming the problem of platform dependences.

Phonegap
It is a cross platform native development framework that enables one to write native applications for seven different platforms, such as IPhone, Android and Symbian, using HTML, JavaScript and CSS. It allows you to convert the web application written using HTML, JavaScript and CSS to a native application based on the targeted platform. In addition, it allows one to use some of the device's specific features, such as Accelerometer and Geolocation. For instance, it converts an HTML5 mobile website to objective C to work in iPhone and iPad devices.

Highchart
Highchart is a very good JavaScript library that allows the data of lightweight devices to be visualized. Not only does it work perfectly with HTML5, but it provides different kinds of charting ranging from a simple pie chart to a more advance dynamic chart. Highchart is a very useful tool that can be used to visualise the data generated by MLA and ULA.

Dreamwehver CS6 and ASP.net MVC4
Dreamweaver CS6 incorporates the stable jQuery Mobile version, HTML5, CSS and JavaScript frameworks which are designed to create an optimised mobile website. Also, it provides the multiple views feature which is very useful in that it allows the user to see how the mobile website will look based on the targeted device sizes, such as an iPhone versus an iPad. ASP.net MVC4 has built-in support to build mobile websites as well.

CONCLUSION
Learning analytics is a landmark technique which has been developed in recent times and which can be utilised to process large volumes of university students' data. Although there are obstacles with its widespread implementation, it has been shown to be a useful method for supporting students who struggle academically as well as students with good academic performance.

Two notions have been introduced in this paper: Mobile Learning Analytics (MLA) and Ubiquitous Learning Analytics (ULA). In terms of MLA, the major source of data comes from mobile learners' data. Non-mobile learner data, which already exists in different university systems, could also provide value in this area. ULA also analyses the data of mobile learners but goes a step further by analysing collected contextual mobile learners' data. In addition, ULA supports its analyses by using existing data about non-mobile learners in various university systems as well. In this respect, ULA can be considered more comprehensive than MLA.

This paper offered an understanding of the importance of MLA by discussing the two possible kinds of explicit interactions between learners, mobile devices and learning material in the mobile learning (m-learning) environment. Furthermore, it provided an overview of the significance of ULA by considering the implicit and explicit modes of interaction between learners, mobile devices, learners' context and the context-based learning materials in the ubiquitous learning (u-learning) environment. In addition, it proposed a Mobile and Ubiquitous Learning Analytics Model (MULAM). Finally, it outlined some of the most important technological developments that could facilitate the move towards the implementation of MLA and ULA techniques for the analysis of mobile learners' data.

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Towards open formats for Mobile Learning

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ABSTRACT

Much of the current discourse in the emerging field of 'mobile learning' looks at traditional learning, happening in existing educational institutions. A parallel (and less well understood) tribe of mobile learners are adults at work, using their own, personal technology to access critical information at their moment of need for 'just in time' and 'as and when necessary' training (Wishart and Green, 2009).

As smartphones become more and more ubiquitous, and the boundary between work and leisure becomes more and more blurred, the expectations of devices and what they can do are higher than they have ever been. Users are tending to use their devices for all aspects of their lives: work, personal organisation, leisure activities, communication, recording etc, and make less distinction between these different activities than before. And as Traxler says, "mobile devices demolish the need to tie the particular activities to particular places or particular times" (Traxler 2011).

This blend between "work" and "play", and increased expectations that any learning apps accessed on your private phone should "perform" as well as any other app, places an impossibly high expectation on educators, learning technologists and mobile developers interested in supporting mobile learning. How to craft a mobile app experience that rivals the best commercial apps available, yet offers rich and pedagogically sound access to resources in a cost effective manner? To do this requires a new methodology that allows mlearning content to "travel well" between platforms, and device types, and provides solutions to a broad range of technology challenges, some of which are unique to mlearning.

As part of their work on the US Government funded Mobile Learning Environment (MoLE) project, the author and his technology team have been wrestling with many of these challenges, whilst creating a suite of mobile content, performance support tools, and job aids designed to be used across many nations, languages and devices. Their software is currently in use in over 20 nations, preparing emergency workers for disaster situations.

Their findings, and technical solutions are already the basis of an open framework for defining and building mobile learning content. This paper describes some of the technical challenges and shares a possible foundation for open sharing and reuse of mobile learning content.

Author Keywords

mlearning, apps, work-based learning, open formats, html5, cross platform development, mobile learning objects

INTRODUCTION

The US Government funded a 2-year technology research project to explore the technical challenges involved in transitioning mobile learning from a peripheral, exploratory study into a core part of their mainstream e-learning delivery. This was done via the Mobile Learning Environment project (MoLE, www.mole-project.net) which developed sample content, tools and platforms for work-based learners involved in humanitarian and disaster relief work. These were deployed as Global MedAid, a mobile app for both iOS and Android currently in use across 20 nations, with 600 learners and multiple languages.

As part of the work, the technology team did practical research and prototype development looking at the underpinning technologies required to deliver meaningful mobile learning tools and content across a range of platforms to a massively diverse user group. Work-based learners have very specific requirements of mobile learning, needing small, easy to access, nuggets of learning and support tools that are quick to locate, and easy to use across a wide range of devices. Work-based learning is multi episodic, often informal and takes place on a just-in-time basis. Although mobile devices are known to foster situated approaches to learning in and across work contexts (Pachler et al., 2011), the employers of these particular learners had previously not allowed this. In addition, the identified user group were expecting to have only occasional access to the internet, and needed to use a mix of resources including:

- compliance-type "courses" that require tracking
- video interviews with domain experts
- active "checklists" as performance support tools
- eBooks, and other existing resources
- mobile reference tools and lookup charts.

Previously, our target group had no mobile access any of these resources. Whilst the mobility of the potential users presents some challenges it also provides opportunities to enhance performance, and contextualise learning. As Kukulska-Hulme points out, the notion of mobility relates not just to physical mobility (of the device or the user), but the opportunity to overcome physical constraints by having access to people and digital learning resources, regardless of place and time (Kukulska-Hulme, 2010).

In designing and developing the optimal set of tools and content for these users, the research team was able to propose frameworks and standards that would apply to a wider range of work-based mobile learners. These standards, though still evolving, have already been adopted by the leading US military e-learning platform as part of a move to mobile. This paper sets out the basic foundations, shares technical lessons learned and outlines the proposed open formats.

TECHNOLOGY AS AN INTEGRAL DIMENSION

When evaluating emerging technologies as tools for learning, it is impossible to separate out the learning from the technologies. This is true from an academic perspective, as well as a technical perspective: the effectiveness of the full learning experience is a complex blend of the learner's own skills, the affordances of the device, the appropriateness of the content, the context of the learning, the fluidity of the software, and the performance of the mobile app itself. Some frameworks for mobile learning (like FRAME by Koole, 2009) make reference to this inter-relationship, showing how the mobile learning is an interaction between the technology, the learner and the context.

This paper emphasises the links between these, with a firm focus on the underpinning technologies, and their appropriateness for mlearning. We look at content issues (like data formats), as well as the technologies required to create interactivities around the content. We look at user interface design, and how this differs across mobile platforms. We look at protocols for sharing packages of mobile content between phones, as well as mechanisms to share tracking data with learning platforms.

When evaluating mobile learning content, we found it beneficial to encompass as many of these dimensions as possible. And when extrapolating that into a strategy for mobile content, some of the more abstract technical dimensions should be included, as well as the learning dimensions. Examples of this would be: ease of navigation; quality of interactivities, and appropriateness for that specific device; "findability" of content on a specific device; range of supported devices; effort required to move content onto a new mobile device. This provides challenges for all the stakeholders in any mobile learning technology development. Some typical dilemmas include:

- for optimum user experience, an app should be developed to target a specific mobile platform (e.g. iOS), but for maximum portability it should not
- for maximum portability of content the best technical solution is to use a web app (hosted online), but this will exclude all the best phone features (camera, GPS, other apps, etc)
- for the best learning experience, users need to be able to work offline, but for integration with traditional e-learning systems, their information needs to sync online.

The solution to these technical dilemmas is to recognise the connectedness of the content, the interactivity, the app features and the learning itself, and to try to extract out open, re-useable formats and standards that allow these different dimensions to travel well between different learners, and different platforms.

Unlike the more traditional e-learning model, mobile learning does not expect one single app, or course to provide the entire breadth of learning content. It is assumed that a small amount of well-contextualised information is better for learning than a larger, and more general course, and that part of the benefit of mobile access to info is being able to jump into a small nugget of personalised information, rather than a larger, more structured course. (see Sharples, Taylor & Vavoula, 2005 for a typical example). This makes it all the more relevant to support a larger pool of small learning nuggets that can be seamlessly assembled in different combinations, for different learners, on different devices.

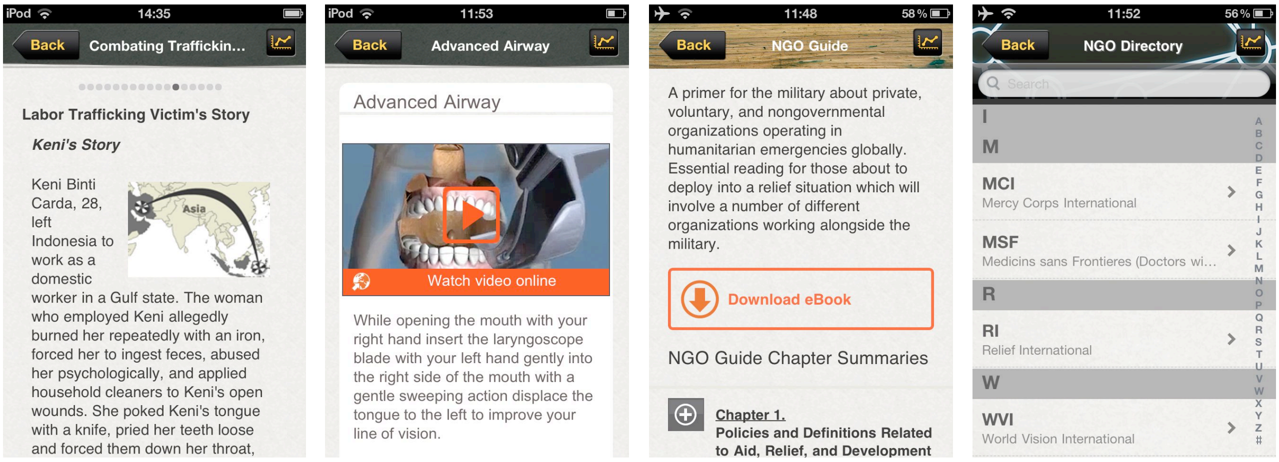

Figure 1: Range of different types of content from Global MedAid app

TECHNICAL APPROACHES TO SHARING MOBILE LEARNING

For learning technologists developing mobile learning apps, there are three main approaches to technical development:

1) Open apps: software techniques enabling developers to build an app once, that is able to run on different mobile phone platforms, (cross-platform development).
2) Open content: content formats that allow individual pieces of content to display on multiple devices. Either via industry standard "players" (like eBook readers), or even better, with native device support (like audio files)
3) Open content with embedded interactivity: this is often seen as a hybrid between the above two approaches, and is the ideal scenario for learning interactivities, as it allows a combination of both content and appropriate learning interactions.

All three of these were explored during the technical developments of the MoLE project, and the core findings follow.

OPEN APPS: APPROACHES TO CROSS PLATFORM APPLICATION DEVELOPMENT

Despite many technology enthusiasts engaging in this area, there remains no perfect answer to the question of how to develop a mobile application once that will work on all phones. Despite significant work from players including the W3C Core Mobile group (http://www.w3.org/community/coremob) and the Open Mobile Alliance (http://www.openmobilealliance.org) to promote best practices and mobile standards, there remains no simple solution to cross platform development, and no consistent guidelines or frameworks to address common problems like the delivery of cross-platform content that works seamlessly on any device.

As each vendor implements its own application development stack, achieving cross-platform and cross-device consistency is a non-trivial task. Fortunately as the web becomes ubiquitous and its technologies evolve, with more and more mobile browsers implementing new standards like HTML 5, CSS 3 and JavaScript, web applications are rapidly becoming an attractive and cost-efficient way of developing mobile applications, that can rival native apps in terms of rich user experience and access to advanced capabilities like storage and geo-location. Fortunately, mobile learning enthusiasts are not the only people looking at this challenge, and a range of tools and frameworks to support cross-platform development have flourished and evolved over the last couple of years. The main approaches that are currently available are outlined below (Hartmann &Stead, 2011).

Cross Compilation (code once, generate native apps)

A cross-compiler separates the build environment from the target environment, effectively decoupling a source from its target. The mobile app developer codes in a third language (like JavaScript, Ruby or Java), using a special API (Application Programming Interface) to build the mobile application, including the user interface, data persistence and business logic. The code is then processed by a cross-compiler that transforms it into platform-specific native apps for the different platforms that the application will run on. The software artefact generated from this process can be deployed and executed natively on the device.

The advantages of this technique are: performance, as the application is running natively on the device; improved user experience, since the app behaves like a regular app on the user's ecosystem; and full native access to a range of device specific capabilities like integrated camera, sensors, etc. The big disadvantage is complexity, since cross-compilers can be difficult to write and need to be kept consistent with the fragmented mobile platforms and operating systems available.

High profile platforms offering this approach include: Appcelerator Titanium; Rhodes (rhomobile)

Mobile Web Apps (run in the mobile browser)

Another increasingly popular approach is to build the app as a mobile web application that will run on the user's mobile browser. This involves using standard web technologies like HTML, CSS and JavaScript to build the application and make it look and behave like a native app. This is possible due to the advanced capabilities of HTML 5 and CSS 3, including embedded SQL databases, local storage, animations, canvas, web sockets and video playback. Although HTML 5 is still a young technology (the standard is yet to be finalised) and mobile browsers may implement it differently, its increasing popularity in rendering engines like the WebKit (which powers the iPhone and Android mobile browsers) allow web apps to look and behave more and more like native apps.

For certain classes of application this approach is appealing, as it is quick to develop and potentially covers a wide range of platforms with minimal changes. This includes common business applications like news readers, e-books, mobile banking, social interaction and e-mail. However it is less suited for highly interactive, CPU-intensive and visually rich applications like games, augmented reality browsers and videoconferencing.

Web apps would typically run in a standalone mobile web browser (pure web). The web approach brings some advantages, like simplified deployment and immediate availability, since most modern phones come with a browser installed and to run the app the user just needs the URL and an active data connection to get started. The big drawback would be a poorer user experience (the browser is never as interactive as the native phone), and restricted access to advanced device capabilities like contacts, storage and sensors.

Hybrid Mobile Web Apps (Web-style content embedded in a native app)

A variation of the above is to have a native app that embeds a browser inside it, allowing for some of the advantages of a natively built app, together with the benefits of portability that come with web-based content (hybrid web). In this hybrid model, the web app runs inside a thin "wrapper style" native app which provides a bridge to the device's operational system and services. The web application is cached locally on the device on installation, removing the need for an active data connection and improving its speed and responsiveness. The communication between the web app and the native app normally happens over JavaScript via custom built APIs.

This technique combines the best of both worlds into one single integrated solution: flexibility of web apps with speed and feature richness of native apps. This approach can offer wider support over many devices, without needing to redevelop the content itself. It also allows developers to compensate for failings in mobile browsers on specific devices by adding extra "native" features where the mobile browser cannot cope.

A high profile framework offering this approach is PhoneGap (http://phonegap.com/), recently acquired by Adobe.

Mobile Widgets

Finally, leveraging web technologies, vendors have created another way for mobile web sites to run like native installed applications. The approach has many different names, but is normally referred to as 'mobile widgets'. The widget concept was introduced long before the mobile app and app store revolution and can be seen as a first stab at delivering small nuggets of functionality in a lightweight and intuitive way to the end user. Popular mobile widget platforms include: Symbian/Nokia Web RunTime engine, Sony Ericsson's Xperia widget engine, BlackBerry's Widget SDK and Samsung's TouchWiz widgets.

A widget is an interactive tool that provides a single-purpose service to the user, such as showing the latest news, current weather, date and time, calendar, dictionary, map, calculator or even a language translator [Wikipedia]. On mobile phones, widgets normally appear on the home screen or virtual desktop. Mobile widgets are small apps normally written using standard HTML, JavaScript and CSS. The use of web technologies is invisible to the user, and the application can work just like any other software installed on the device. The platforms normally provide JavaScript APIs, so widgets can access device capabilities such as the camera, contacts and storage, like a regular native app. This is very similar to the hybrid approach described earlier, the only difference being the packaging and access to phone capabilities, since normally widget API's are richer than bespoke cross-platform libraries based on HTML 5.

Although standards were created to help promote and standardise the widget landscape, they are still not widely adopted by vendors, creating a similar fragmentation to that in the mobile app development world. Fortunately, since most widget engines leverage JavaScript, it is possible to reuse almost all the code, creating a multi-platform widget engine.

Summary

The project team did a detailed analysis of these different approaches, building several prototypes, and testing performance, and ended up selecting a blend of several approaches:

For our own apps, we now use the hybrid model, keeping all mobile content in HTML format, but hand-coding 'native' app code to provide any system level functionality. We use the open source PhoneGap framework as the basic building block, but then create custom native extensions to add learning-specific functionality.

This allows us the performance benefit of native app features, without sacrificing content portability. For our mobile content/learning objects, we used the formats defined in Web Apps, or Widgets allowing the same content to play in multiple apps, on many different mobile platforms.

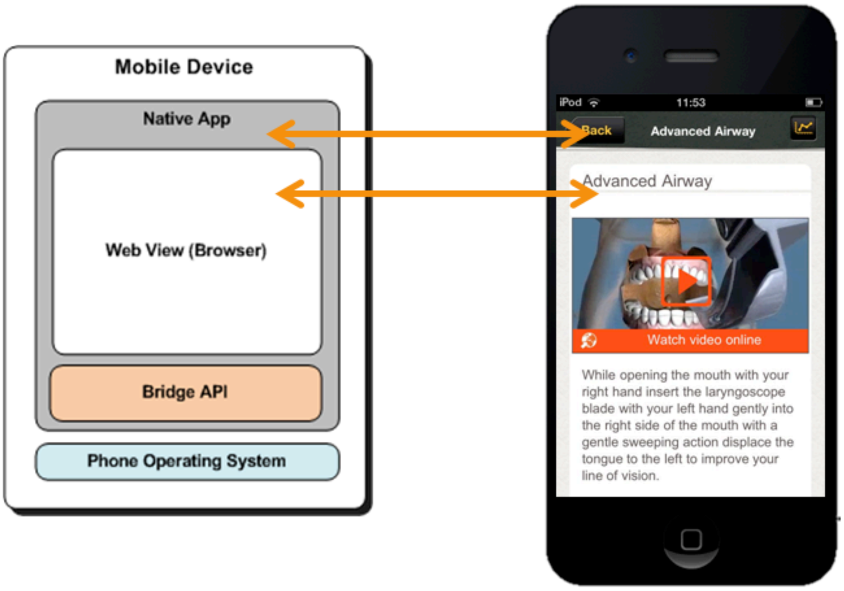

Figure 2: App architecture mapped against a real page from Global MedAid app

OPEN CONTENT: FORMATS FOR MOBILE LEARNING CONTENT

There are many established and emerging standards for compressing and sharing mobile media files. Some define the file format itself, and others how files relate to one another. To maximise the future use of mobile learning, these formats ought to underpin any new mobile learning development. We thus developed “mobile content guidelines” that were shared by all project partners, and ensured the base format of all mobile learning content would be governed by ‘mobile web standards’, regardless of whether the content itself is destined for the web. The basic design principles selected were:

- Individual media files should be optimised for mobile, and stored in as open a format as possible.
- Media should be formatted for cross-platform playback, avoiding platform-specific formats.
- As much of the interactivity as possible should be delivered via browser-supported technologies - in most cases this means using HTML5, Javascript and associated web formats.
- Content layout should flow (dynamically adapting between landscape and portrait, as well as a range of screen sizes)

For specific media types, we tested multiple formats across a range of platforms, and found the optimum formats to be:

Video and audio

There are many different audio and video formats available, and most devices (such as the iPod) and programs (such as Windows Media Player) will only take a few specific formats. An AVI or WMV movie will not play on an iPod, for example, without being converted into an MP4 file. There are a few formats, however, that DO have close-to-universal support from smartphones.

Audio	File format: MP3 or AAC	http://en.wikipedia.org/wiki/MP3 http://en.wikipedia.org/wiki/Advanced_Audio_Coding
Video	Video Codec: H.264 File format: MP4; Audio codec: AAC	http://en.wikipedia.org/wiki/H.264

eBooks
Where a large amount of text is required, eBooks proved an ideal format for sharing and packaging downloadable, text-based materials in a real, global format. There are multiple formats available for eBooks, but for maximum coverage these are the key formats (http://en.wikipedia.org/wiki/Comparison_of_e-book_formats):

- ePub: rapidly becoming the gold standard. Works on almost all eBook readers (except some Kindles, and older phones):
- MobiPocket (.mobi): The gold standard for mobile phone based readers. It is not dissimilar to ePub (some treat it as an earlier format of ePub).
- AZW (Amazon's Kindle format): this is exactly the same as .mobi, but renamed (can be .mobi, .prc or .azw)

All three of these are based on XHTML / CSS (so a bit like a package of web pages). Although the eBook readers themselves are very much like web browsers, they have limited layout controls. Most only use their own inbuilt fonts (ignoring what you tell them). Another option is:

- pdf (Portable Document Format): All modern smartphones can load pdf files directly. This is good (for portability), but very bad for mobile optimized legibility. Unlike the formats above, the layout is fixed. The page does not reflow to fit the screen. The fonts don't really resize meaningfully. This makes for tricky reading

We found the best format was ePub (though we would also convert the same file to .mobi and .azw to reach wider devices).

OPEN CONTENT WITH EMBEDDED INTERACTIVITY: FORMATS FOR MOBILE LEARNING CONTENT
One major advantage of the "Hybrid Mobile Web Apps" approach mentioned above is that the mobile content itself can be rendered (displayed) in an embedded web browser inside the app. This allows for a rich ecosystem of content. Anything that will work as a web app can work as mobile learning content.

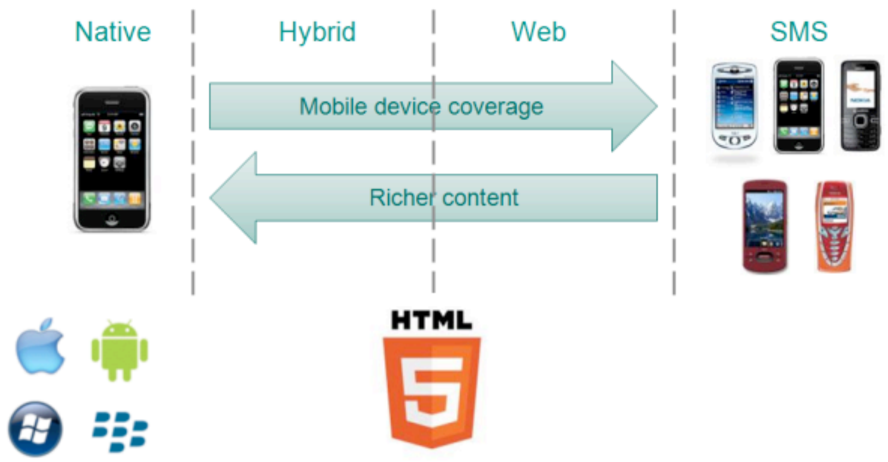

Figure 3: Spectrum of mobile technologies against reach

Figure 3 shows a typical technology spread. On the left, a hand-coded native app offers the richest functionality, but for one type of device only. On the far right, a simple text message can reach any mobile device, but with very limited ability for interactivity. In the middle are the web technologies, either delivered online or via a hybrid app.

HTML5 as an ideal format:
Because of this, we defined Mobile Learning Objects (or micro-courses) as self-contained HTML packages (not unlike SCORM packages (an e-learning standard), or the W3C Widget definition). This is extremely open ended, allowing developers the freedom to use XHTML, HTML5, and any combinations of CSS and JS to support their content, and add richer functionalities.

Any functionality supported by the local webview (web browser) is available to course developers. There are 2 different technical approaches that can be adopted:

1. Pure HTML, generic JS: by only using HTML and Javascript with 100% browser support you can ensure that your content is truly 'develop once, play on all devices', but you are limited in the richness of the interactivity.
2. Optimised for different devices: to exploit a wider range of device-specific features, adaptive JS calls can be created that detect the browser type, and render optimised pages for each.

Good examples of this are by using JQueryMobile (http://jquerymobile.com), Sencha Touch (http://www.sencha.com/products/touch) or perhaps using WebKit specific JS calls (http://www.webkit.org) to achieve animated effects. If developers use these approaches they can develop richer interactivities, but need added skills to ensure proper playback across all devices and graceful degradation where these features are not supported. These are the technological approaches, but to create truly engaging mobile content, a lot of effort needs to go into the design and interactivity. Many of the guidelines for making good mobile websites are useful here, though not all advice is relevant for a downloaded mobile learning package.

Useful reference sites include:

- Jacob Nielsen's advice on 'designing for mobile': http://www.useit.com/alertbox/mobile-vs-full-sites.html
- Design advice from These Days Labs: http://labs.thesedays.com/blog/2010/07/16/10-tips-for-designing-mobile-websites

Some of the main points to consider are:

- cut features, to eliminate things that are not core to the mobile use case;
- cut content, to reduce word count and defer secondary information to secondary pages;
- design with a fluid layout to cope with different screen sizes (min-width: 320px);
- use CSS3 for visual effects (rather than older web based approaches, like image slices);
- enlarge interface elements, to accommodate 'fat fingers' (suggest 44x44px).

Because the content is displayed via the local browser, developers can test their content by running it live in a browser, or by downloading it direct to a mobile device.

ZIP + XML to package mlearning files:

For packaging a collection of media and HTML files, we turned to the more established standards for sharing e-learning content (SCORM Content Packaging), which in most cases is done by zipping up a collection of HTML pages, and including core metadata to define the content. Some aspects of this approach are perfect for mobile (a single file representing a package of content, in an open, web accessible format). Other aspects are not (bloated file formats, excessive metadata, reliance on a SCORM player to support all API calls).

For our content packaging, we used a reduced version of SCORM CP, with a much lighter set of metadata. This allows the content to be entirely standalone, in that it can be unzipped to play directly in any mobile browser. But it can also be downloaded and unpackaged by our app, in which case it integrates seamlessly into the learning app, allowing for tracking and monitoring of progress.

Formats for messaging and tracking:

Traditionally e-learning used the SCORM API as a structured method to pass tracking data from the content to the learning platform. Although widely supported on the big screen for traditional e-learning, SCORM is not yet widely established in more dynamic learning environments (virtual reality, social media, etc), nor on the smaller screens with mobile learning, and is widely considered too restrictive for tracking the wide range of learning activities typical on a phone (Degani et al, 2010). Several parallel initiatives are underway, sponsored by the e-learning industry, to explore alternative methods of sending progress data to a learning platform. Key ones are:

- LETSI (http://letsi.org): protocols for passing progress data back to a learning platform *without* requiring the content to be hosted by it.
- Tin Can (http://scorm.com/tincan): a replacement for the SCORM API, allowing a wider range of content to send more descriptive update on progress. Like LETSI content does not need to be hosted on the tracking site.

Both of these standards are of interest for mobile learning. We borrowed from each, though did not do a full implementation of either, as these were not core requirements for the project. We used Restful Web Services to exchange information with our web server (similar to LETSI), and a linear stream of progress updates via a JavaScript API to pass data from the content to the app (like Tin Can).

COMBINING THESE APPROACHES FOR AN OPTIMUM MOBILE LEARNING FORMAT

For our target groups (work-based learners using their own phones) we found the combination of technologies listed above, a perfect solution to developing and sharing mobile learning content. We leveraged and extended existing standards, and open source projects where available, and borrowed concepts from e-learning where helpful. Our focus was specifically on touch-sensitive smartphones, (primarily Android and iOS, but also Windows Phone).

CONCLUSION

As mobile learning is adopted more widely, and the quality of mobile learning content is enhanced, it is becoming increasingly important to ensure that good quality mlearning content can work on many devices, across many networks, and in multiple languages. The MoLE project has been working to establish an open set of standards for mobile learning content to allow for maximum portability and reuse, without locking out the most useful aspects of mlearning: the phone features themselves!

Drawing on existing standards in related domains (mobile web, html, e-learning, video, zip) it has been possible to define formats for both mlearning content, and applications themselves that allow for open sharing and future extensibility of mlearning across multiple devices, and platforms. By embracing multiple media formats, and a wide range of use case scenarios, the best possible learning content can be made available via whichever channel is available to that learner.

At the time of writing, over 300 learners across 24 nations are already using content developed to these standards (via four different initiatives), and key stakeholders in the USA government e-learning community have adopted this approach (and our app) as core to all their future mobile courses.

The platform and content standards are still evolving, and an ongoing dialog and improvements to these techniques is always welcomed.

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Everyday patterns in lifelong learners to build personal learning ecologies

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ABSTRACT

This article presents the results from a questionnaire filled out by 147 lifelong learners. The primary aim of the questionnaire is to analyse learning practices of adults, and to recognize patterns of lifelong learners in order to support them with technology. These patterns capture the context in which lifelong learners are more willing to learn, that is, the day of the week, duration, location, activity being performed, type of device being used, way to interact with their devices and how these aspects can affect when an adult student takes the initiative to learn. Moreover, this article examines previous publications on surveys, questionnaires and information collected with the same objective, to corroborate and contrast the findings. The contribution of this paper is identifying and describing patterns in which lifelong learners are more willing to build personal learning ecologies when supported by mobile devices.

Author Keywords

Mobile usage patterns, lifelong learning, personal learning ecologies, survey

INTRODUCTION

Lifelong learners are confronted with a broad range of activities they have to manage every day. In most cases they have to combine learning, working, and everyday life throughout the day. For the support of lifelong learners, their daily practices and learning patterns are of importance. Lifelong learning includes a variety of different educational scenarios and contexts in which learners operate. These contexts include traditional formal programs, non-formal education, on the job-training and informal, accidental learning. Fischer (2000) even values lifelong learning as a mind-set that people have to acquire including the following learning scenarios: self-directed learning, learning on demand, collaborative learning and organizational learning.

One of the most critical challenges for the implementation of lifelong learning is to integrate real world problems and learning in the same process. One promising approach to connect the worlds of working and learning is a pattern approach. According to Alexander (1977) each pattern describes a “problem, which occurs over and over again in our environment, and then describes the core of the solution to that problem”. Rohse & Anderson (2006) propose design patterns that should enable the detailed formalized description of “the dynamics between learning and technologies without the potential ideological or pedagogical mask of teaching in formal education and training settings”. In the setting of an adult lifelong learner this is especially difficult as in most cases interests might be highly distributed over different domains and keeping up learning needs an extra effort. Lowing the barriers for access to relevant information and support services anywhere, anytime, and anyhow is one essential component for efficient lifelong learning support.

The idea of a Personal Learning Environment (PLE) recognises that learning is on-going and seeks to provide tools to support this kind of learning. It also recognises the importance of the individual to organize his or her own learning in order to embed it in contexts of daily life (Attwell, 2007). Personal Learning has been hierarchized into learning activities, episodes and projects (Vavoula & Sharples, 2002) (Tough, 1971). Vavoula & Sharples (2002) define “learning activity” as the distinct acts that the person carries out during reading, discussing, listening and making notes. Tough (1971) defines a “learning episode” as a well-defined period of time that is held together by the similarity in intent, activity or place of the thoughts and actions that occur during it; it has a definite beginning and ending in time. “Learning projects” are formed by grouping episodes together on the basis of their contingency in terms of purposes and outcomes that could happen at different locations.

A QUESTIONNAIRE FOR LIFELONG LEARNERS

This article describes the results from a questionnaire filled out by 147 lifelong learners (Tabuenca, 2012 – ANNEX I to VII). The questionnaire was distributed both in English (ANNEX I) and Spanish (ANNEX II) taking advantage of the following channels: social networks, three Dutch and Spanish universities, two high schools from Belgium and The Netherlands, two companies, one academy for skills-training and the author´s blog. The survey was stored in an on-line platform[1] so that everybody could access and fill out the questionnaire making use of the distributed URL. Answers were collected over the course of three months. Participation was voluntary and unrewarded.

The questionnaire is composed by 21 items, these are, 5 multiple choice questions, 6 single select questions, 9 matrix selection questions, and 1 open answer question. An introduction section (60 words) was included in order to explain the aim of the questionnaire and to define frequently used concepts within the items. These concepts are: *a) Mobile device: regular phone, smartphone, tablet, multimedia player and laptop when used not always in the same place; b) Learn: taking the initiative to learn something actively. It can be related to work, current studies or self-fulfilment*.

There are 4 questions about demographics (age, genre, occupation, and professional domain), 3 questions about usage patterns with mobile devices, 2 questions about how timing and content are related, 7 questions linking activities, locations, and ways of interaction with lifelong learner's mobile devices, 1 question identifying difficulties when learning with mobile devices, 3 questions about the lifelong learner's motivation, and 1 more question to estimate how familiar is the concept of *lifelong learning* for the participants.

The data with the answers has been exported from the on-line survey platform to a spreadsheet (ANNEX III) file. This file has been imported with a database engine in order to create a table (ANNEX IV) for each of the questions in the survey. A database client has been used to build joining-table queries (ANNEX V), aiming to find patterns in the answers given in different questions. Chart reports (ANNEX VI) have been created from these requests to carry out the analysis (ANNEX VII).

The results of this questionnaire are presented including references to previous studies on mobile device usage patterns and mobile learning support, in order to contrast and corroborate the conclusions.

Results from the questionnaire

The concept of "lifelong learning"

Participants where given the following definition in order for us to assess how familiar were they with the concept of "lifelong learning": "*All learning activity undertaken throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment-related perspective*" (European comission 2011). When particpants were asked whether they considered lifelong learners themshelves, 21.76% reported a negative answer. However, it is paradoxically that these same respondents answered positively to the question "*Do you have a natural motivation to learn*?"

Patterns based on type of device, lifelong learners' behaviour and timing

The presence of mobile devices in lifelong learners' daily activities is a fact and this can be gathered from the results of the questionnaire. Portable computers are used every day by 70.06% of the respondents. Smartphones are used every day by 56.46% of the respondents, while 17.68% use their tablet on a daily basis.

Trends indicate that smartphones and tablets are the cornerstone in future learning designs since they are even more portable than portable computers. The smartphone is easily carried around in a pocket and can be used in any moment of the day. A study performed by Arbitron (2011) concluded that engagement with different smartphone features is divided evenly during the day detecting a slight peak in the afternoon from 15h to 18h.

Our results show that there are two time slots of the day in which lifelong learners feel more motivated to learn, these are from 10h to 12h (55.78%) and from 16h to 20h (49,66%). This discontinuity is happening due to the pause to have lunch, in which generally people change their context, that is, using a way of transport or simply commute the place for some time. Our study (See Figure 1) shows a difference for "motivation to learn" between people that own a smartphone and those that don't own one. Individuals that own smartphone expressed to be more constantly motivated during the day when compared to non-smartphone users.

[1] Questback on-line survey platform, http://www1.questback.com

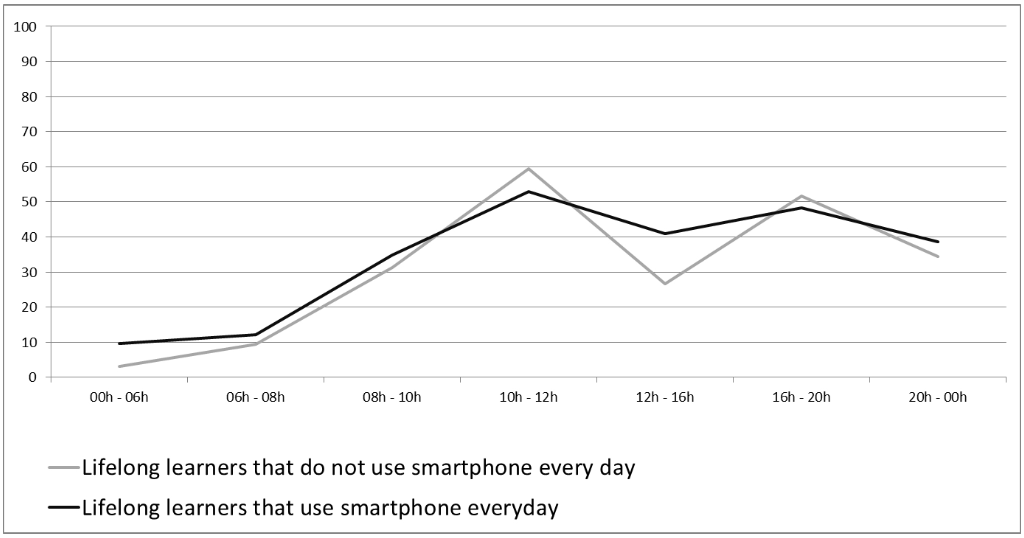

Figure 1. Motivation to learn during the day. Smartphone users vs. non-smartphone users.

A study by Eoff (2011) based on one week click data in the bitly on-line link tracking platform[2], concluded that tablets (iPads) usage during the day is not flat and drastically different when compared to other type of devices, including smartphones and portable computers. These results suggest that usage lowers after breakfast, remains low during traditional working hours and does not peak until much later in the evening (19h to 0h). The results of the questionnaire for lifelong learners suggest that there is an association between tablet users and their motivation to learn. The percentage of tablet users motivated to learn was 10% higher than with individuals that do not use tablets (See Figure 2). In relation to the peak observed late in the evening by Eoff (2011), our results show that the learning-motivation-curve in tablet users in the last hours of the day does not descend so much in comparison to non-tablet-users.

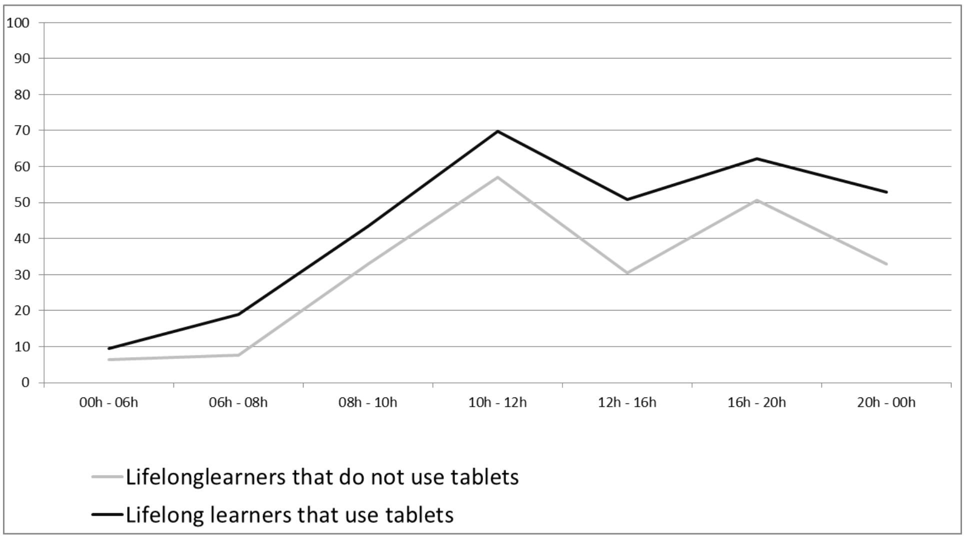

Figure 2. Motivation to learn during the day. Tablet users vs. non-smartphone users.

Eoff's results (2011) suggest that tablets are mainly used for entertainment purposes since they are less used than the rest during working times. Tablet usage is higher in comparison to the rest of the devices during leisure time. This effect can be also observed during the weekends when tablets usage between 8h and 15h is higher than it is during the week at those same hours. No other device sees a heavy increase of use during the weekends.

When asking lifelong learners on which days of the week, do they spend more time with their mobile device(s), our results show (See Figure 3) that usage for smartphone-users is flat with a slight peak on Fridays and there is always a

[2] An on-line link tracking platform. Bitly. https://bitly.com/

higher percentage in comparison to non-smartphone users. There is an increase of 30% in non-smartphone-users from a working day (Thursday) to weekend day (Saturday).

There are different ways of consuming multimedia contents with mobile devices, these are, listening, reading, writing, watching, and. When lifelong learners were asked how long on average they spend on each of these ways of interaction, 21% of the individuals reported to listen more than one hour per day to their mobile devices. This preference for listening can also be inferred from the results. Media players are used at least once a week by 64.62%, of the respondents.

When lifelong learners where asked how much time do they spend on different topics per day, the outcome was that *study*, *music* and *social networking* are the activities on which they spend most of their time. In contrast to these results, the study performed by Arbitron (2011) with similar topics, indicates that messaging, browsing, social networking and voice are the activities on which individuals spend more time.

Examining the way how individuals check their mobile phone for a new SMS, missed call, email or any other notification, there are two different behaviours that can be gathered from the results of the questionnaire. There is a first group of individuals (37.41%) that only check incoming notifications when the device warns them with an alert. The second group's behaviour is performed by the individuals (34.68%) that check it continuously, this means, at least once per hour. Comparing behaviours between genders, it is remarkable that the option "I only check my mobile when it alerts me" was answered by 44% of the men and 28% of the women. Women's behaviour was more evenly distributed among the rest of the options ("once a day" and "once every four hours").

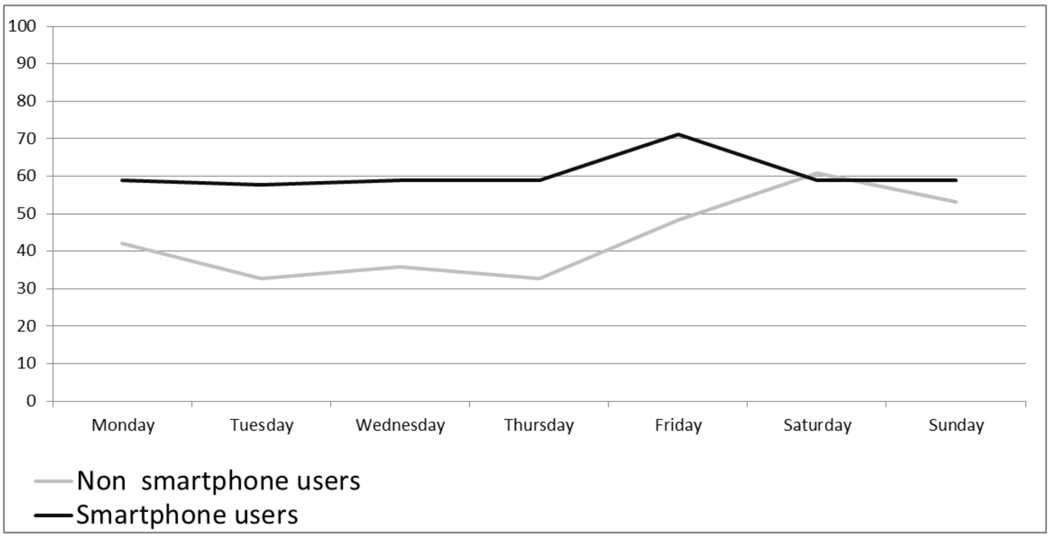

Figure 3. Mobile device(s) usage during the week. Smartphone users vs. non-smartphone users.

Linking locations, activities and ways of interaction with mobile devices

A study performed by Media (2011) on 5013 adults who identified themselves as using their smartphones to access the Internet, concluded that there are two main situations where they use smartphone. These are being at home (93%) and on-the-go (87%). Moreover, adults were requested for which activities they also use Internet on their smartphone. The highest rate was obtained (59%) for the activity "*Waiting (in the line at the market, doc, office, bus, etc.)"*. The questionnaire for lifelong learners has focused on these three main contexts including six items with the aim to identify patterns that link locations (living-room, kitchen, bathroom, working/sleeping room, on-the-move and, waiting for someone), actions normally performed in those locations (e.g. having breakfast, brushing your teeth, lying on bed, and etcetera), and ways of interaction with mobile devices (listen, watch videos, write and read), also defined as *learning activities* by Tough (1971). These results have raised some interesting differences regarding the way in which participants reported to behave depending on their gender.

Being at home

Sitting in the sofa is the most popular place to interact with mobile devices, not only compared to any activity performed being in the living-room or anywhere at home, but also outdoors and on-the-move. Exactly 62.58% of respondents reported that they normally *read* contents, 50.34 % *write* contents, 44.89% *watch videos* and 34.01% *listen* to audios while being in the sofa. The *living-room* was reported to be the most popular place to read contents, and specifying more, being *sat in the sofa* and *watching TV during advertisement time* (47.61%). There was also a high rate of respondents that reported to write contents while *watching TV during advertisement time* (32.64%).

The main finding that can be gather from responses regarding the context *being in the bathroom* is that, this intimate place has a significant association with mobile device interaction when used for *listening*, that is, the individuals reported to listen while *having a shower (23.12%)*, *making-up/shaving (*18.36%*)* and *brushing their teeth (*18.36%*)*. Being *on the toilet* is the most compatible activity with the different ways of interaction, that is, 33.33% of the respondents used their mobile device to read, 21.08% to write and 11.56% to listen. The poll performed by (Media, 2011) stated that 39% of the adults had used the Internet on their smartphone while using the bathroom, and 8% while taking a shower/bathing.

The majority of the respondents (54.42%) reported that they normally read contents on their mobile devices while *being sat at the desk*, 51.69% read, 37.41% listen and 29.92% watch videos, this means, that the desk is the best place to interact with mobile devices while *being in the room*. Furthermore, the bed is suited to interact with mobile devices reading (50.33), listening (34.69), watching (34.01%) and writing (33.32%).

The kitchen is a location associated to perform learning activities while "listening" on mobile devices. The results from this questionnaire suggest the same effects than the ones observed to the context *being in the bathroom* where mobile devices are mainly used for listening. The main contexts where participants embed their listening-learning-activity are while *cooking* (30.6%) and *heating the breakfast* (25.84%). It is only remarkable that 16.32% of the respondents interact with their mobile devices to *read* contents while cooking, probably requesting cook-recipes or short messaging while boiling, frying or anything in the oven. The survey by Media (2011) indicated that 27% of the participants had used the Internet on their smartphone while cooking/and or other household chores.

Waiting

Results depict that *waiting for someone/something* is not a context in which respondents consume video contents in contrast to the rest of ways of interaction, since the rates are low varying from 15.64% (being in the airport) to 4.76% (waiting in a commercial centre). The bus stop (43.52%) and the train station (41.49%) are the most suitable places to interact with mobile devices reading contents while waiting for someone/something. When writing on mobile devices, the highest rates are evenly distributed (approximately 38%) for the following contexts: waiting at the bus stop, at the train station and anywhere in the street.

On-the-move

The results from the study performed by Kim, Jimwoo, & Yeonsoo (2005), indicate that the most common context for using mobile Internet is described as follows: *participants have a hedonic goal, their emotional state is high, their legs are stopped, visual and auditory distractions were low, few people are around them, and their interaction is low*. This is a different picture from the widely held belief that the mobile Internet would be used often while moving outdoors. However, mobile devices have improved their capabilities to access the Internet since 2005, e.g. bigger displays, touch screens and faster connections and mobile interaction with smartphones is different nowadays. Our results suggest that interaction with mobile devices on-the-go is mainly carried out *listening*, being 51.69% train, 50.33% bus, and walking 48.3%. *Reading* contents is the second most popular way of interaction when moving, being 50.33% by train, 40.82% by bus, and 36.73% accompanying the car driver. The train is the most popular place to interact with mobile devices while *listening*, *reading* and *writing*, and the plane is the most popular place to *watch* videos. The poll performed by Media (2011) stated that 43% of the individuals had used the Internet on their smartphone while commuting to work/school and 20% driving by vehicle.

Gender

Regarding the gender effects, our results show some evidence on the fact that certain learning activities were more pronounced in men than in women and vice versa. On the one hand, there are a 44.18% of men that reported to use their mobile devices reading contents while being sat on the toilet, however only 18.02% of the women do so. This difference was also notable for writing contents (29.05% men vs. 9.83% women) and watching videos (15.11% men vs. 3.27% women). However, gender did not moderate the effects of listening contents. On the other hand, differences were also found regarding to listen to contents in some particular places. Women reported to be more willing to use their mobile devices while cooking (42.60% women vs. 22.08% men), sorting groceries (26.21% women vs. 5.81% men) in the kitchen, and cleaning in the living-room (49.16% women vs. 29.05% men). Moreover, it is remarkable that for the context *waiting for someone/something in a commercial centre*, 37.24% of the men reported to read contents in their mobile devices while only 16.38% of the women reported so.

	Listen	Watch	Write	Read
In the living room				
Having breakfast	12,24	8,16	8,84	29,24
Cleaning	37,4	1,36	0,68	2,04
Sitting in the sofa	34,01	44,89	50,34	62,58
Having lunch	11,56	10,88	8,84	20,4
During cofee/time	19,72	11,56	27,2	38,77
Watching TV, during advertisement time	12,92	15,64	32,64	47,61
In my room				
Waking up in the morning in bed	18,36	2,72	7,48	25,84
Getting dressed	19,72	0,68	1,36	2,04
Sitting at my desk	37,41	29,92	51,69	54,42
Lying on bed anytime	34,69	34,01	33,32	50,33

Figure 4. Learning activities in context with mobile devices. Percentage of individuals.

	Listen	Watch	Write	Read
In the bathroom				
Having shower	-2,49	1,16	0	1,16
Sitting on the toilet	2,95	11,83	19,22	26,15
Making up / shaving	-10,63	-3,27	-3,27	-3,75
Brushing your teeth	-8,51	-2,11	0,68	2,53
In the kitchen				
Preparing breakfast	-11,85	2,05	-2,38	-0,32
Sorting groceries	-20,4	0	0,68	-5,39
Cooking	-20,52	1,58	-1,9	-8,51
Waiting for someone/something				
In a commercial center	-9,52	2,53	14,3	20,85
Traffic Jam	-7,67	6,02	7,33	5,43

Figure 5. Learning activities in context with mobile devices. Difference in percentages between men and women. Positive numbers represent higher male percentage. Negative numbers represent higher female percentage.

Missing learning activities

Participants were asked whether they had missed in the questionnaire any other activity where they usually get along some learning episode with or without their mobile devices. They reported sport activities like “running”, “cycling” or “at the gym”, on-the-go activities like “taking a walk” or “walking the dog”, and some other miscellaneous ones like “having lunch/dinner alone in a bar”, “feeding the infant”, “taking care of infant” and “while doing some do-it-yourself labour at home (carpentry, plumbing…)”. The poll performed by Media (2011) concluded that 48% of the adults had been eating while using the internet on their smartphone, 17% walking their dog and 13% playing sports. Another respondent reminded us that there are no patterns for every situation and he/she reported “*I just learn something when I find the time*”.

Difficulties when learning with mobile devices

Wong (2010) identified ten seams by which learning experiences are disrupted today and for which Mobile-assisted Seamless Learning (MSL) technology has to find new solutions. The identified ten gaps (MSL1-10) in seamless learning support are of high relevance for lifelong learners. Participants were asked about seven of these ten gaps in two items of the survey. The remaining three gaps (MSL5, 9, 10) were too complex concepts to deal in this poll and will be treated in suitable future studies.

The above paragraphs “*On-the-move*” and “Patterns based on type of device, lifelong learners’ behaviour” provide evidences to confirm the existence of both “across location” (MSL4) and “across time” (MSL3) gaps in the participants. Some cues are also exposed on how to resume these gaps supported with mobile technology. Participants were requested to report how often do they encounter these difficulties (MSL1-3 and MSL6-8) when learning and assisted with their mobile devices. The results from the questionnaire indicate that participants, varying from 12% to 17% in the different MSLs “usually” find these difficulties. Nevertheless, approx. 34% of the respondents reported “not a difficulty” in all these difficulties. The most remarkable difficulty is “find suitable slots of time during the day” with a 21.08% of the respondents that reported to have it “usually” and a 4.76% that find it “always”. Slightly higher rates to the three resting difficulties, and with similar rates between them were “Combined use of multiple device types (laptop, mobile phone and/or tablet)” and “Linking real world to what I learned digitally” with approximately 17% of the respondents that “usually” found these difficulties.

An extended study performed by Eurostat (2011) concluded that the two most commonly cited obstacles to participation in education and training among those who wanted to participate but did not do so were: lack of time due to family responsibilities (36.6 % of those not participating); conflict with work schedules (35.0 %).

DISCUSSION AND CONCLUSION

The aim of this questionnaire for lifelong learners is to analyse learning daily activities in adults, and recognize patterns in lifelong learners, in order to shed light on new ways to support them with technologies. Results obtained in this questionnaire arise the 10 following findings:

1. Portable computers are the most used type of device. Recent studies (Wesel, 2011) (Wesel, 2012) have found similar results arguing ergonomic reasons. Furthermore, students preferred bigger screen compared to smartphones or tablets. Moreover, we think that portable computers are supplanting the heavy desktops because the drop in the prices (Tapellini, 2011) (Kharif, 2009) in the last years.
2. Individuals that own a smartphone reported to be more constantly motivated to learn during the day than non-smartphone users.
3. Individuals that own smartphone use them constantly during the whole week. The rest of the individuals reported lower usage during working days and an increase during the weekends.
4. Listening is the most compatible learning activity when performing other tasks at the same time. It is also the one where adults spend more time and in longer time-slots. These results suggest that audio is very suitable for distributing learning materials. Audio contents can be consumed from any media player, which are very affordable since they can be found independently or embedded in most of the phones.
5. There are two different behaviours when adults check their mobile phone for a new SMS, missed call, email or any other notification. There is a group that only checks incoming notifications when the device warns them with an alert. There is another group that check it continuously. These results suggest that two behaviours must be taken into account when building mobile applications for learning. Users attend to notification coming from his/her mobile device: continuously polling; check based on warning event (vibration, sound, icon on the screen desktop…).
6. There is an association between the learning activity being performed (reading, listening, writing, or watching) and the concrete location where it takes place. Some patterns were found in the way to interact with mobile devices while being at home and depending on the room where the individuals were located. Participants were more willing to perform any kind of activity with their mobile device(s) while being *in the living room* or *in the sleeping/working room*. Nevertheless, participants reported that *the kitchen* and *the bathroom* were places where they use to perform the "listening" learning activity.
7. Learning activities are mainly performed when adults are with their legs stopped. The "reading" and "writing" learning activities mostly take place being sat (sofa, desk, train, bus and toilet) or lying on somewhere (bed). *Sitting in the sofa* is the concrete place where adults reported the higher acceptance when carrying out any learning activity. However, the "listening" learning activity that takes part more evenly in the different locations and embedded in different activities.
8. Men and women behave in a differently when making use of their mobile devices. These results suggest that man and women seem to behave differently, not only in the way to perform learning activities depending on the context, but also in the way to attend to an incoming notification on their mobile phones. Furthermore, the study performed by (Ofcom, 2010) stated that men spend nearly an hour more per day using media than women.
9. Lifelong learners reported that their learning experiences are disrupted. Finding a suitable time slot to learn during the day is the most frequent difficulty reported by participants. These results and the ones by Eurostat (2011) suggest that there is a need to integrate learning activities in daily life.
10. There is a high rate of individuals that are not familiarized with the concept of "lifelong learning".

The authors of this paper strongly believe that the combined use of multiple devices will support lifelong learners to build their own Personal Learning Ecologies (PLE). On the one hand, lifelong learners are typically active in several parallel learning tracks, which they have to manage. This can be inferred from the above mentioned study (Media, 2011) stating that 72% of the users could operate with books, personal computer, watch TV or listening, while using the Internet on their mobile device (multitasking). On the other hand, the results from this questionnaire position the smartphone as a potential key element to link learning across locations, time, and supporting lifelong learners to keep the pace of the motivation while changing the context. This fact positions smartphones as a key element to track adults' PLEs, since they provide a continued presence in learning activities. As adults advance anytime and anywhere completing learning episodes, they are getting along their self-organized personal learning.

We will extend this research creating a lifelong learner-centred model in which smartphones will be able to interact with smart objects (ambient displays, sensors, learning containers, etc.) that could trigger different activities and lead to learning events. Moreover, we will define how channels and artefacts can be related in order to adapt and serve the information according to adults' preferences (location, embedded in learning activity, time of the day, duration of the task, gender, etc.).

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A gender digital divide? Women learning English through ICTs in Bangladesh

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ABSTRACT
In Bangladesh, the BBC Janala project is using multimedia to give adults opportunities to learn English for economic purposes. English lessons are available on mobile phones, the web, a newspaper and a TV show. Despite the large numbers of people accessing the BBC Janala media products, there is a gendered digital divide, with much fewer women accessing the web and mobile lessons in particular. In this paper, I look at case studies of three adult women learning English through the BBC Janala mobile, web and TV lessons, the barriers faced and the perceived English learnt. Findings indicate that gender inequalities in Bangladesh mean that although the women have high barriers to participation, learning English through ICTs helps to break down some of these gendered barriers.

However, the different ICTs also carry different perceptions of educational value. Despite the web lessons having the highest gendered barriers to participation, they were perceived to carry the most educational value. Learning English through mobile opened up access to the web lessons, giving the women more choices in their learning. This means that although mobile learning may not be seen as a valid form of learning by the respondents, it can however create access to methods of learning that are perceived as more valid.

The research also found that social norms severely restrict the women's choices of the ICT they use and there is a real possibility of a future gendered English and ICT skill imbalance in Bangladesh. As a response to some of the issues identified in this research, the British Council in Bangladesh is piloting an English and ICT project for girls, in partnership with BRAC Bangladesh, to try and address this gender digital divide.

Author Keywords
women, ICTs, mobile, gender, digital divide, Bangladesh, development, education, English language learning

ICTS AND DIGITAL BANGLADESH

A widely accepted definition of Information and Communication Technologies (ICTs) is the one given by UNDP, who define them as 'information handling tools... goods, applications and services that are used to produce, store, process, distribute and exchange information' (UNDP, 2003, cited in Dighe and Reddi, 2006, p. 20). Commentators often draw a distinction between non-electronic ICTs, such as radio and television, and digital ICTs, such as computers, mobile phones and the Internet (Gurumurthy, 2006; Dighe and Reddi, 2006).

In 2008, the Bangladeshi government launched the Digital Bangladesh initiative. Its aim was to significantly expand ICT usage across the whole of Bangladesh by 2020, working through different partnerships with organisations such as the World Bank and the British Council. This initiative rests on the premise that ICTs can have a positive impact on poverty reduction and gender inequality, through creating access to education for women (BORN, 2009; GoB, 2011). One of its aims was to use these ICTs to build English skills (BORN, 2009). This emphasis on skills and education lays testament to the crucial role in development that education plays. According to the Human Capital Theory, a prevalent standpoint in policy circles, education is an investment that yields economic benefits, creating an educated population, resulting in higher lifetime earnings, economic growth and social returns (Woodhall, 1987). These social returns include reduced fertility and mortality rates, and improved life expectancy (Schurmann, 2009). Clearly, education plays a key role in poverty reduction (UIL, 2009).

Going on this argument, investing in English language skills as a form of education allows people to improve their employment prospects and yield economic and social benefits, both at an individual and macro level. An example of investing in English language skills is the DFID-funded English in Action (EiA) project, involving a consortium of partners working closely with the Government of Bangladesh. EiA uses ICTs to equip millions of Bangladeshis with English language skills that will 'enable [them] to participate more effectively in economic and social activities' (BBCMA, 2011, p.2) by improving access to the world economy. However, levels of English proficiency are low in Bangladesh, though—in 2009, a study concluded that the vast majority of the population had very low spoken English competency due to the lack of opportunity to practice the language (EiA, 2009a).

BBC Janala

One strand of the EiA project, BBC Janala, run by BBC Media Action (BBCMA), targets adults learning English through ICTs. Aims include changing people's perceptions of learning English, improving their attitudes towards learning English and increasing their confidence, as well as reducing barriers to English learning, such as lack of access and high cost. The 2009 baseline survey revealed that the media technology eventually used by BBC Janala was already diffused among the adult population. In 2008, over half the adult population had access to a mobile phone (BBCMA, 2009), with high rural rates of access (EiA, 2009b). The number of mobile phone subscriptions has since increased by over 40 per cent, reaching 72 million in March 2011 (BTRC, 2011). The BBC Janala mobile lessons provide voice-only lessons for even simple handsets, allowing users to listen to a lesson by dialling a short code. Users of the mobile service reached 4.8 million in October 2011 (BBCMA, 2011).

Figures for computer and Internet use in Bangladesh are still extremely low—only 2.8 per cent of the adult population used the Internet in 2009 (Nielsen, 2009). However, this is rapidly changing. The number of Internet users increased five-fold from 2000 to 2007 (EiA, 2009b) and doubled again from 2008 to 2009 (BBCMA, 2009), and it is believed that this trend will continue. While personal computer ownership remains low—2.3 per cent in 2008 (World Bank, 2010)—there are many cyber cafés around the country and over 80 Internet service providers (ISPABD, 2011). The BBC Janala web lessons are extremely technologically simple, with light pages designed for low bandwidth, and do not require advanced computer literacy skills.

Television is the most widely used medium across all social classes. In 2008, a quarter of all households owned a television (EiA, 2009b), with 70 per cent of the population watching television regularly (BBCMA, 2009). From October 2010 to April 2011, two English language learning shows – *Bishaash* and *BBC Janala Mojay Mojay Shekha* – went on air on BTV, the state broadcaster, three times a week. *Bishaash* is a drama, mostly in Bangla with some English content. *Mojay Mojay Shekha* – which means 'learning with fun' in Bangla – is a game show that teaches English through quizzes, comedy sketches and competitive team games. In March 2011, the adult viewing figures for the two shows stood at 26 million (BBCMA, 2011), a quarter of the total adult population in Bangladesh.

This particular study focused on the BBC Janala lessons on mobile, web (through a PC) and television. All the lessons contain similar educational content, and the web and television lessons are free. The mobile lessons cost $0.02 for a three-minute lesson - a heavily subsidised rate achieved through partnership with six major mobile operators. All the lessons use Bangla as the medium of instruction, and the materials are developed for a Bangladeshi social context.

BBC Janala's primary target group is adults aged 15 to 45. Usage of BBC Janala products within this population is marked by large gender differences. In the baseline survey, the majority of male respondents cited economic benefits as the primary reason for learning English, while female respondents tended to cite social benefits (BBCMA, 2009). There is also a large gender difference between usage of particular ICTs, particularly for mobile and web users, a pattern that is also reflected in the ICT use of the general population, as table 1 shows (BBCMA, 2011).

	Television		**Mobile**		**Web**	
	BBC Janala	General population	BBC Janala	General population	BBC Janala	General population
Male	55%	57%	88%	67%	84%	81%
Female	45%	43%	12%	33%	16%	19%

Table 1: The breakdown of ICT usage by gender, for both BBC Janala media products and across the general population.

THE STUDY

This particular study formed part of the author's MA dissertation at the Institute of Education, University of London. The study explored the potential reasons for the large gender divide, and what this could potentially mean for the Digital Bangladesh initiative and its aim of using ICTs to improve English skills. The study used two methods of enquiry. One involved an intensive literature review of primary and secondary data across the region, to look for potential reasons for this gendered digital divide. The other method of enquiry involved individual, in-depth interviews with three different women, using purposive sampling (Merriam, 1998).

The BBCMA Research and Learning team has a cohort panel of 120 panelists, tracked since 2009, from the target population and recruited from the baseline survey. The three respondents were selected from the cohort panel for their different BBC Janala media product usage and their gender. Thus, Respondent M is a primarily mobile user, Respondent W a primarily web user, and Respondent T a primarily television user. As there is a lot of cross-usage across media platforms, respondent selection was based on the ICT they used *most frequently*. For example, Respondent W also occasionally uses the mobile and television services. This cross-usage was unavoidable for mobile and web, due to the low numbers of women accessing these particular services. The low numbers meant that it was not possible to control for other factors such as education level and socioeconomic class in this sample of three women.

The respondents

The web user

Respondent W is a 22-year old Masters student living in an urban area. She is unmarried and lives with her parents and younger brother. W has been using the Internet for eighteen months and taught herself how to use it. In 2010, her father bought a home computer with Internet access for her brother's studies, which enabled W to teach herself Internet skills.

W aspires to study for a PhD abroad and her learning English, Internet use, and aspirations are intertwined. She wants to learn English to facilitate her studies abroad, but also feels that she needs to learn English to use the Internet to research PhD funding because of the predominance of English websites.

The mobile user

M is a 41-year old government employee in a semi-urban area. She is married with two young children. Her husband does not work, and she is the family's financial provider. M wants to learn how to use the Internet and to start her own business, which is linked to her reasons for learning English. For her, learning English will enable her to use the Internet to get business information from English websites. In addition, M wants to earn status and respect from others through English: to M, being an educated mother who can speak English earns her children prestige in a society where higher levels of education equate to higher status (Sperandio, 2011).

M owns her own mobile phone and pays her own bills. She has never used a computer or the Internet, and her office has only one computer, which she has never used. She has been a regular user of the mobile lessons since the service began, and it is her only method of learning English.

The television user

T is a 32-year old housewife and is married with three young daughters. She has less than ten years of education and no formal qualifications, having married young. Because her in-laws saw no reason for a married woman to be educated, she left school against her personal wishes.

T rarely leaves the family home and the domestic responsibilities fall on her. She values teaching her children and giving them educational opportunities, and motivation for learning English is linked to this. She feels that if she can learn English, she can help her daughters with their studies.

Because of time constraints and domestic responsibilities, T does not learn English formally. The family has only the state broadcast channel, and T watches *Bishaash* and *Mojay Mojay Shekha* with her children every week. She has a mobile phone, but her husband pays the bills and she does not want to use her phone credit to call the mobile lessons. She has never used a computer or the Internet, and does not feel able to go to a cyber café because of her domestic responsibilities and prevailing social norms, which are explained in more detail later on.

Methodology

The interviews took place in Khulna, Magura and Dhaka in the respondents' homes. The interviews were conducted in Bangla, through a female interpreter who had interviewed the respondents in the past for the BBCMA and recorded. Later, a different interpreter transcribed the recordings into English. The study also drew upon primary qualitative data recorded by the BBCMA Research and Learning team since 2009, including questionnaires, structured and semi-structured interviews, and respondents' background data. The main question being asked was: how can learning English through ICTs help the women achieve their life ambitions? The cohort panel interviews revealed the women's reasons for learning English - the mobile user wanted to learn English so that she could use the Internet, the web user wanted to learn English so that she could apply for a PhD abroad, and the television user wanted to learn English to teach her children - but how far did they feel that their use of ICTs had helped them to learn the English for this? Secondly, what barriers did these women face? Why did the mobile user use the mobile service and not the web? Was it a question of choice or was it a lack of choice? What barriers do these women face in using ICTs to learn English?

Barriers to participation

From the literature review and from the in-depth interviews with the three women, it emerged that the main barrier to participation for women was access to ICTs. Three main related issues underpinned this issue of access: control, social norms and language.

Firstly, there is an issue of control. Patriarchal norms and constraints over mobility mean that in Bangladesh many women are restricted to the domestic sphere and aren't able to visit a cyber cafe to use the Internet unchaperoned. Public ICT facilities, such as cyber cafés, are often men-only places, where women are either not permitted inside or feel uncomfortable frequenting (DAW, 2002). In addition, due to domestic responsibilities, women often have time constraints and cannot visit public facilities during daylight, while public mobility at night is restricted for many women, often due to male relatives' fears of sexual harassment (Hafkin, 2002), something that is particularly likely in a predominantly Muslim country like Bangladesh.

As well as control over mobility, control over finances and decision-making also tend to belong to male relatives (Raynor, 2008), who often pay phone and Internet bills, and are often the primary users of shared mobile phones and computers (GSMA, 2010). Therefore, women frequently have less autonomy with regards to ICTs and related expenses. In addition, men are often gatekeepers of technology, and control women's use of mobile phones and computers, or television channels.

This is related to the idea of social norms. Bangladesh is traditionally a patriarchal society based around a family unit that maintains 'rigid social understandings about… expected norms for male and female behaviour' (Sperandio, 2011, p.124). Gender discrimination is 'deeply entrenched' (Chisamya et al, 2010, p.4), with a woman's role traditionally being that of wife and mother (Islam and Sultana, 2006) and women often confined to the private sphere (BEPS, 2002). Generally speaking, it is the man, as head of the household, who has control over most areas of a woman's life, including mobility, decision-making and allocation of education and health resources.

A cultural preference for sons (UNESCO, 2003) means that women are often seen as burdens, with many families perceiving female education as a wasted investment, as a woman usually leaves the family home upon marriage (Raynor, 2008, p.8). Therefore, many adult women don't have a high level of education and don't have the confidence to learn. For those women who did finish school, cultural norms may have prevented them studying traditionally 'male' subjects such as maths or technology (Aikman and Rao, 2010), which can have knock-on effects on confidence in using ICTs.

Related to this, the BBCMA baseline survey showed that women tend to use less English in their day-to-day lives than men (EiA, 2009b), and are more likely to have lower levels of English; something compounded by their lower levels of education. However, language is a key cause of marginalisation (Hafkin, 2002; UNESCO, 2010). Most websites are in English and require a minimum level of English proficiency, which is a barrier for many Bangladeshi women. However, currently eighty per cent of the software and content being developed for the Digital Bangladesh initiative is in English (Chowdhury, 2011). How can women use ICTs to develop English skills if the ICTs are in a language that is inaccessible to them?

KEY FINDINGS

The findings from the study showed that learning English through these ICTs helped break down some of these barriers. Firstly, it gave the women access, bringing the lessons and the learning into the domestic sphere, allowing them to juggle domestic responsibilities with learning. It also made the women feel that they would be able to access and use the Internet. Learning English through television or mobile opened up access to the Internet by helping the women overcome the language barrier and at the same time increase their confidence in their own English ability and their own ability to use ICTs. As the mobile user put it, if she was able to learn English by herself through mobile, then it followed that she should be able to learn how to use the Internet, by herself. In her mind, she had learnt enough English to be able to do that.

One of the biggest barriers to language learning in Bangladesh is confidence, as the baseline survey showed. For these three women, learning English through these ICTs helped reduce this barrier of confidence: confidence in their ability to learn English and confidence in their ability to use other ICTs to learn English. For example, the television and mobile users felt confident in the English they had already learnt through more accessible forms of ICTs and felt that they would then be confident enough to able to use the less accessible ICT to learn English. This then gave them more options in their learning and allowed them more choice and control over their learning, meaning that to some extent, their learning helped them break down the barrier of control.

When asked about which ICT they felt carried the most educational value, all three women in the study saw learning English through the web lessons (through a PC) as the most valid form of learning, regardless of access, and learning television as the least. However, the rate of access of the web lessons is only a quarter of that of the mobile lessons and significantly less than that of the television lessons, for both sexes (BBCMA, 2011), meaning the lessons with most perceived potential for improving English skills also have the lowest rate of access. This perception was also backed up by other respondents in the midline survey (BBCWST, 2011). This could be accounted for by the fact that in Bangladesh, perceptions of what real learning is means that less conventional methods of learning such as learning through television or learning through fun doesn't fit in with the norm of what education entails, and therefore is perceived as less valid.

What this means is that on the one hand, more accessible ICTs like mobile can help create increased confidence in being able to access the web, but on the other hand the woman who used mobile didn't feel that her learning carried as much weight as it would have had she learned through a computer.

CONCLUSIONS: THE BRITISH COUNCIL – BRAC PROJECT

What is to be made of this? It seems that there is an imbalance. On the one hand, many people in Bangladesh see learning English as essential, economically speaking, in order to get better jobs and improve livelihoods. It is also becoming more economically essential for women in Bangladesh because social norms are changing and there is more of a diversity in family income. However, on the other hand, there is a gender digital divide which can potentially lead to a greater imbalance of English skills between men and women in the future, leading to potentially increased gender inequality. This is particularly true in a context where Digital Bangladesh aims at gender equality but so much of the content and software developed so far is in English, raising questions about the further marginalisation of women through language.

It is much easier to challenge perceptions of learning and who should be able to learn, and the BBCMA midline survey shows that for a large proportion of women, their perception of English as difficult and their confidence in their English level and their ability to learn English is changing in a positive way (BBCMA, 2011). But there are obvious issues with access and ownership for these women, which will affect the English skills of these women and need to be addressed. The question is now - how can we increase access for women so that learning through ICTs is meaningful for them? Clearly, using low-cost available technologies such as mobile can help create access to less accessible ICTs such as computers – but the danger is that mobile learning is perceived to carry less educational value.

In the Bangladeshi context, it is evident that addressing problem of access requires first and foremost thinking about structural inequalities within society. The first step is for an educational organisation to partner with other organisations in Bangladesh who have already, or have the resources to, set up a community ICT centre for women. These community ICT centres can provide unrestricted access to ICTs in a safe environment, and provide training and guidance for these women.

This is what the British Council in Bangladesh has done. Building on the findings of this study, the British Council has partnered with BRAC, a Bangladeshi NGO, to set up a network of community ICT clubs for adolescent girls, tapping into BRAC's long-established Adolescent Development Programme. The clubs provide an informal space where participants can experience learning English through the British Council's digital English resources, preloaded in an offline format onto small notebook. The clubs are peer-led and meet twice a week, after school. Guided by the peer leaders (who have been initially trained by BRAC and the British Council and have continual mentoring and support), the participants use the notebooks to navigate the resources, which use songs, games and interactive activites, mapped to the Bangla curriculum and supported with Bangla text.

The overarching long-term aim is to help to close the gender digital divide and address issues of skill imbalance, breaking down barriers of access and confidence by providing access to both English and ICTs in an interactive, enjoyable and accessible way in a safe space, allowing the participants to develop ICT skills through learning English (as opposed to developing ICT skills through straight computer training). It is also hoped that it will change perceptions of what educational value learning through less traditional methods, such as through ICTs carry. Although the pilot does not currently use mobile as the main ICT (because of the nature of the piloting materials available), it is hoped that this will be possible in the future, once the proof of concept is established, especially given the prevalence of mobile technology in Bangladesh.

The baseline survey revealed that none of the participants had ever used a PC or the Internet before, including the peer leaders – with some having never even seen a computer. All the participants however wanted to learn English and ICT skills as part of their life ambitions – they had just not had the opoortunity or access. The pilot is currently halfway through, but initial findings indicate that the participants' perceptions of their English level and their ICT skills are increasing rapidly, with some participants asking for more digital resources without the Bangla supporting text – an indication of confidence in their ability. Attitudes towards learning through less traditional methods also appear to be changing.

However, in terms of real empowerment, although it is possible that the ICT clubs alone would have an effect on the agency of the women through ICTs, in reality it can only be effective if conducted in tandem with governmental policies concerned with addressing wider social inequalities that affect Bangladeshi women, which include addressing issues of language marginalisation and ICT access within the Digital Bangladesh initiative.

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Low Cost Mobile Phones for Large Scale Teacher Professional Development in Bangladesh

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ABSTRACT

Education has the power to transform societies and contribute to social and economic development. In this paper we present the mobile technologies used for teacher professional development (TPD) and communicative language teaching in English in Action (EIA). The project aims to assist 25 million people access greater social and economic opportunities through English language teaching and TPD. EIA, in partnership with the Government of Bangladesh, will work with 80,000 teachers through a work-based programme of TPD using audio and visual resources on low cost mobile phones. With access to over 700 audio files aligned with the national textbook *English for Today* and professional development films that explain and then illustrate successful student-centred English teaching and learning, the project has already documented significant improvement in teachers' and pupils' English language competency. This paper provides an account of, and rationale for, the changes in the technologies used across two phases of the project, from the iPod Nano and Touch used in the pilot study with 690 teachers (2009-2010) to the low cost Nokia C1-01 mobile phone with a micro secure digital (SD) being used in upscaling to 12,500 teachers (2012-2014). We argue the low cost alphanumeric mobile phone with micro SD cards provides unprecedented opportunities to both deliver TPD and improve teachers' and students' communicative English language skills. The paper considers the unique suitability mobile phones present for resource constrained education systems in developing countries. Simultaneously we highlight the need for further application and research into the use of mobile technologies, not only for large-scale TPD projects, but for a diversity of international development projects and programmes which aim to achieve sustainable change at scale.

Author Keywords

English in Action (EIA), large scale teacher professional development, mobile phones, Bangladesh, international development

INTRODUCTION

The People's Republic of Bangladesh is one of the most densely populated countries in the world (UNPD, 2007) and largely monolingual. Bengali or Bangla is the language of 95% of the population (BANBEIS, 2003) and this is largely due to the circumstances that led to the Bengali Language Movement, which later foreshadowed the Bengali nationalist movements and the Bangladesh Liberation War in 1971. It was not until 1990 that English became a compulsory subject from class one of primary schooling (Hoque, 2009). As a result, many primary and secondary teachers struggle with communicative English and have not been exposed to communicative language teaching (CLT) approaches.

Examples of mobile phones enhancing teachers' and pupils' English language proficiency in developing economies like Bangladesh, is uncommon. This paper reports on how English in Action (EIA), a project designed to contribute to the growth of Bangladesh by providing English language as a tool for better access to the world economy, first used MP3 players in a large-scale TPD initiative, then re-designed their technology kit using low-cost mobile phones. We present findings that demonstrate significant changes in classroom practices through the use of mobile technologies as part of a work-based TPD program. We argue that incorporating mobile phones as a teaching and learning tool presents new opportunities for teachers and pupils to acquire English to levels that enable them to participate more fully in economic and social activities.

EIA's work is closely aligned with the democratic government of Bangladesh's Prime Minister's Office's philosophy of 'Digital Bangladesh' and 'Vision 2021'. EIA's approach demonstrates how mobile phones, as a tool, challenges current assumptions around the use of mobile phones within large-scale international development projects. Significant successful findings emerge from classroom-based research, monitoring and evaluation (RME) across urban, suburban and remote rural areas. This robust RME demonstrates the success and potential of using audio and film resources on mobile devices—particularly mobile phones—with lightweight portable rechargeable speakers to provide TPD at scale while simultaneously providing teachers with an unprecedented tool to both improve their classroom teaching and English language proficiency.

English in Action (EIA) is a 9-year project beginning May 2008 and running through to 2017. EIA was designed to assist 25 million people in Bangladesh improve their English language skills. The Government of Bangladesh requested the project and it was then funded by the United Kingdom's Department for International development (DFID). The project is an international partnership, led and managed by BMB Mott McDonald, with The Open University (UK) and The British Broadcast Corporation (BBC) Media Action. Locally, EIA works collaboratively with organizations including the Underprivileged Children's Educational Programme (UCEP) and Friends in Village Development Bangladesh (FIVDB).

EIA's primary purpose is to raise Bangladesh's economic and social profile by providing English language as a tool for the population to access global opportunities. In this paper we describe how EIA is centred around targeted mobile phone-based TPD and the use of audio and visual learning materials on mobile phones with micro SD cards and portable rechargeable speakers. These materials are aligned with the country's English language curriculum and textbooks used in all government schools. The learning resources (print, audio & visual) were developed to improve 12 million pupils listening and speaking skills by providing audio, audio transcripts and visual resources to reflect content in the textbooks. Through face-to-face TPD and self-learning modules in print and on mobile phones, teachers learn how to use these resources in their individual classroom contexts.

'DIGITAL BANGLADESH' AND 'VISION 2021'

EIA is not a development project that works on people. Rather it works with people, particularly teachers to build their capacity to become better teachers and more proficient in their ability to teach and use communicative English. EIA, also works within existing government initiatives and is closely and intentionally aligned with two of Bangladesh's Prime Ministers' Office initiatives: '*Digital Bangladesh*' and '*Vision 2021'*.

'Digital Bangladesh'

The philosophy of 'Digital Bangladesh' is an attempt to ensure the citizens of Bangladesh's democracy and rights. It aims to be transparent, accountable, establish justice and ensure the delivery of government services through the widespread use of technology to improve the lives of Bangladeshis regardless of class or social status. The government has emphasized the four elements of the 'Digital Bangladesh' vision as human resource development; people involvement; civil services; and use of information technology.

Government 'Vision 2021'

The Government of Bangladesh is committed to building a country whose citizens are able to live prosperous and happy lives by the year 2021, which marks the golden jubilee of Bangladesh's independence.

> For the Government's vision to be realized, the potentials of ICT sector will also need to be realized and software industries and IT services will need to be developed with an digital infrastructure to support digitally-savvy entrepreneurs, young people and citizens. The Prime Minister's Office's A2I regards it as a "remarkably pro-poor manifesto" that "represents a modern day translation of the vision of a "Sonar Bangla", or golden Bengal, promised by the Father of the Nation Bangabandhu Sheikh Mujibur Rahman" (A2I, 2011, p. 3).

Not ignoring these government initiatives, EIA sought to leverage technology currently available to help ensure these ideals are made a reality, or more precisely model how technology could be leveraged within a cyclical work-based programme of TPD to bring about real change in localised classroom contexts. EIA's model aims to be sustainable and is currently forging partnerships with national and local partners, including teacher-training institutes, to embed EIA materials and student-centered pedagogy into these institutionalised programmes.

The programme is now in its third phase (2011-2014), having completed a pilot phase during which 231 primary and 115 secondary schools participated and 753 English teachers and teacher facilitators (trainers) were trained using the programmes' resources on MP3 players with portable rechargeable speakers. The lessons learnt from this phase formed the basis for revision of materials, technology kit, teacher training and support mechanisms. The model which is being used to support changes in classroom practice in shown in Fig. 1. Teacher participation in classroom activities is at the heart of teachers' professional development in EIA and considered to be the primary driver for transforming both their professional knowledge and practice. There are two layers of support provided to teachers, to enable their participation. The first layer of support is always 'on hand' to the teacher while they are in their school; such support includes teaching resources such as posters, flash cards, to be used directly within the new classroom activities, and professional development resources, made accessible through use of mobile technologies, for teachers to engage with in preparation for, or reflection upon, carrying out the new classroom activities.

Mobile devices have played a key role in the teacher support model described above and as the programme has progressed, the technological requirements and devices deemed appropriate have also changed. The remaining part of this paper will examine these changes and the impact achieved.

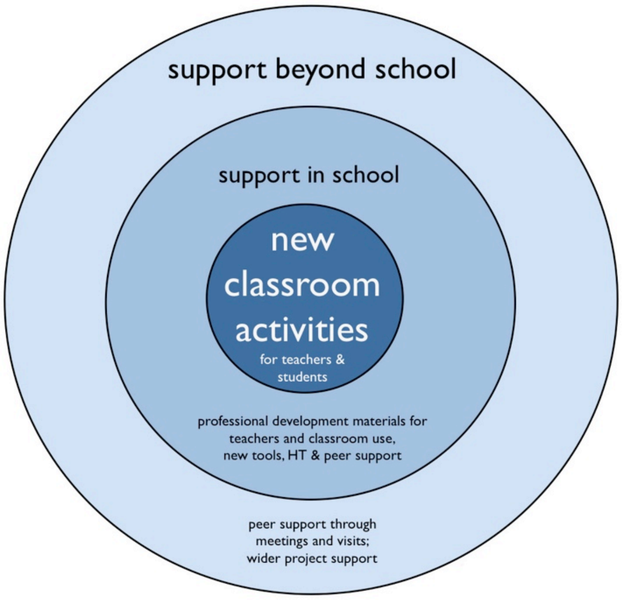

Figure. 1 EIA's work based model to support changes in classroom practice

PROFESSIONAL DEVELOPMENT AND CLASSROOM RESOURCES ON MP3 PLAYERS

During the pilot phase of the project (2008-2011) the teachers were provided with professional development resources preloaded on the Apple iPod Nano (for primary teachers) and Touch (for secondary teachers) and portable rechargeable speakers. This 'trainer in your pocket' (Walsh, 2011) included 18 film clips and 4 audio recordings for primary teachers that exemplify a range of correct and incorrect English CLT classroom practices. Figure 2 is an example of the 'trainer in your pocket', an ICT-enhanced TPD film entitled, 'Doing pair-work' developed by The Open University. It was designed for teachers' self study and exemplifies the incorrect (red x in the lower right hand corner) and correct (green check in the lower right hand corner) ways to introduce and implement pair work in an English communicative language teaching (CLT) classroom. The secondary teachers were supplied with 46 audio files and podcasts enhanced with synchronised text and images. This was the core of their ICT-enhanced TPD materials. Secondary teachers also received a print-based TPD package entitled, *English for Today in Action*, that presents 12 CLT modules (Active listening, predictive listening, using visual aids, creative writing, etc.) that they can adapt and use to teach communicative English.

Prior to going to scale the use of the mobile technologies described above were piloted in 15 schools. To assess the initial impact after six months, twelve teachers were interviewed. Data from the interviews concluded the use of mobile technologies within a work-based programme of TPD was "shown to facilitate access to learning, as well as improving the quality of teacher education and training...and to bring about changes in classroom practice" (Shohel, 2010, p.213). Teachers reported a change in their practice as a result of having access to resources on the mobile devices:

> Previously, *I used to teach them using text books … Now I can teach* the students using a new method instead of traditional methods by *selecting from a set of methods* given in the iPod. It's also helping the students to *increase their listening skill significantly*. (Shohel, 2010, p.206)
>
> *That* [iPod Materials] *helps me to learn the language and use it in the classroom context. I did not know the language earlier in this way. I knew, but not in this way. I did not even think of taking these to students. I could not think of teaching English of this level to the students! Even we did never learn in this way! We never got tips!* (Shohel, 2010, p.206)

The teachers despite demonstrating a positive attitude and indicating changes as a result of using the mobile technologies also indicated significant challenges. These included the difficulties inherent charging multiple devices in suburban and rural areas that lack a reliable source of electricity in some and the chosen speakers not being loud enough for all students to hear the audio recordings aligned with the national textbook.

The pilot phase with 690 teachers then commenced across the country and both internal and external evaluation provided encouraging results in terms of improvements in classroom practices and English language competencies of teachers and students (discussed in greater detail below). However the project needed to rethink the mobile technology to be used for the current upscaling phase which aims to reach 12,500 teachers by 2014. The research indicated the iPod Nano, Touch and portable rechargeable speakers provided teachers with TPD resources that enabled them to change their teaching practices while also providing students with near native examples of English speaking related to their textbooks. But project budget constraints and going to scale first with 12,500 teachers, then an additional 67,500 (through 2017) required a cheaper technology kit, with low-cost components, that could potentially be part of institutionalised programmes. This led to testing and trialling various technologies including alphanumeric mobile phones and micro SD cards.

Figure 2: ICT-enhanced Teacher Professional Development on the iPod Touch

PROFESSIONAL DEVELOPMENT AND CLASSROOM RESOURCES ON LOW COST MOBILE PHONES

Using mobile phones for TPD in emerging economies, like Bangladesh, is a promising field whose applications are context specific and largely absent from the literature. Studies exist that exemplify the importance of this technology, but they remain largely outside education and almost completely outside TPD. Yet, EIA believed mobile phones would not only be suitable to deliver the professional development materials, but could also be used to help teachers reflect on and document the changes in their classroom practice. This lead EIA to field-test a number of mobile phones and portable rechargeable speakers with teaching and professional development resources on micro SD cards in rural contexts with limited and/or no electricity. EIA's goal was to assemble kits for distribution to teachers across the country, some with limited and/or no electricity. Importantly, after 2014, the project budget will not allow us to provide the additional 67,500 teachers with mobile phones, but it is likely the project can provide them with micro SD cards (or a similar mobile technology not yet available) that they can use in their own phones.

EIA identified the Nokia C1-01 mobile phone (£38), with 2GB micro SD cards (£1) preloaded with all of EIA's audio and film materials and portable rechargeable amplifiers (£25) as the best technology 'kit' to achieve EIA's goals in line with 'Digital Bangladesh' and 'Vision 2021'. These Kits have been distributed to 5000 teachers across the country (2012) and will eventually be provided to 12,500 teachers in total by 2014. The mobile phone field test indicated the Nokia C1-01 best met project needs as mobile phones saturation among teachers is nearly 100% and is an essential tool in their daily lives.

Communicative English Language Teaching Resources on the Nokia C1-01

Drawing on the success of the pilot studies, EIA redesigned its professional development materials for use on mobile phones and repackaged all of the audio files aligned with the national textbook for use on the Nokia C1-01. For teachers, principal teaching resources are now the series of audio materials on the Nokia C1-01 (Figure 3). They include dramatisations, songs, stories and a cast of characters from a fictional school. In some ways, the audio resources are similar to those that might be used in Interactive Radio Instruction (IRI), but with much greater emphasis on teacher and pupil agency, creativity and independence than typical IRI materials, being preceded and followed by recommended activities that do not rely on the audio file. For secondary teachers, the main teaching resources on the SD cards are also audio files, representing all of the English readings within the national textbook series, and enhanced by additional stories, songs and other materials; the secondary materials bear no resemblance to traditional IRI materials, and are simply resources for teachers to use in classroom activities.

Figure 3: Communicative English Language Teaching Resources on the Nokia C1-01

For primary and secondary teachers, the professional development materials on the Nokia C1-01 are audio and film files stored on the micro SD cards. These were designed to accompany 8 discrete print-based modules (different for primary and secondary teachers) that cover listening, speaking, reading and writing communicative teaching practices, games, grammar, and approaches to teaching in a socially inclusive way. The films begin with a narrator who explains in Bangla and/or English what the modules is about and types of communicative language teaching practices (Figure 4) that will be demonstrated. Then the teachers watch a film that illustrates the practice or approach presented by the talking head (Figure 5). Afterwards, the narrator returns to help the teachers make sense of what they viewed on the mobile phone and how they might try something similar in their own classroom. Importantly, because these TPD resources are stored on the teachers' mobile phones, they can watch them at any time and revisit them in tandem with the pedagogical content presented within the print-based modules (Figure 6). The films are authentic and were produced using teachers who had participated in EIA's programme and learned how to use EIA's materials on the iPod Touch and Nano in the pilot phase. The films illustrate how these teachers have carried out the suggested activities in the modules, making explicit possible approaches to classroom teaching, management and organisation. They also provide real-life examples of techniques being carried out effectively for teachers to see and discuss during their participation in the cyclical work-based programme of teacher professional illustrated in Figure 1.

Figure 4:

Figure 5: Illustration of Classroom Practice

Figure 6: Teacher viewing the professional development materials on the Nokia C1-01

IMPROVED ENGLISH LANGUAGE PROFICIENCY

At the end of the pilot phase, EIA conducted two large-scale quantitative studies to indicate the extent of change observed in the classroom practices of teachers participating in EIA after 1 year. One lesson from 350 Primary teachers and 141 of the Secondary teachers in the project were observed. The results were compared to those observed in a 2009 baseline study, 'An observation study of English lessons in primary and secondary schools in Bangladesh' (EIA, 2009) prior to the project's intervention. The study focused upon the use of English by teachers and pupils, the extent of teacher and pupil talk time, the nature of the teachers' talk, as well as the nature of the classroom activities that pupils took part in. A feature of improved English language teaching was the increase in the amount of pupil talk in lessons, as well as an increase in the use of English by both teachers and pupils. We describe both the primary and secondary findings below

In the first study, observations of primary classrooms indicate a change in teachers' pedagogical practices. This was indicated by the decrease in overall percentage of teacher talk time during the lesson (34%) and an increase in the overall percentage of pupil talk time (27%). When the primary teachers were speaking, they used English the majority of the time (71%). This indicates a significant increase as a result of the their participation in EIA. Earlier only 27% of teachers spoke in English more than they did in Bangla. When Primary pupils were speaking, they also used English most of the time (88%). This was also an increase from EIA's baseline study, which identified few occasions (2-4%) when individual pupils or groups were encouraged to speak in English. Finding were similar for secondary classrooms which also report an increase in teachers embodying English CLT practices and using English 86% of the time.

In the second study, primary (98%) and secondary (98%) teachers reported on interview that they enjoyed taking part in EIA and believed their communicative English language proficiency improved. As a result of their familiarity and experience including using the mobile audio technologies, most teachers (96% Primary; 86% Secondary) felt more confident in using and modeling spoken English in the classroom. More important findings indicate the majority of teachers (86% Primary; 92% Secondary) have changed their pedagogical practices to focus on communication, with grammar being explained in context; 91% primary and 90% Secondary of secondary teachers report often designing activities to have pupils interact in English; and all secondary teachers and 93% of primary teachers report improved pupil motivation as a result in changes to classroom practice. The second study indicated that both primary and secondary pupils reported that teachers used English most of the time in lessons and that they often participated in English CLT practices (activities such as group and pair work, dialogue, and listening activities with mobile audio). Primary and secondary pupils also indicated that they preferred these new communicative classroom activities to more 'traditional' pedagogical practices which can generally be characterised as the 'grammar translation' method of teaching English. Using this method, teachers often only translate the English into Bangla, not providing students with the opportunity to actually use English for communicative purposes.

In addition, Trinity College externally evaluated teachers' and students' English language proficiency using the Trinity Graded Examinations in Spoken English. Each interviewee's spoken English was evaluated against the criteria of the 12-point Trinity College English Language scale. Grade 1 represents very little spoken English competence and grade 12 indicates complete competence. The grades are sub divided in four stages: initial (1-3); elementary (4-6); intermediate (7-9); and advanced (10-12). In 2010, independent assessors interviewed 367 primary and 176 Secondary teachers before the EIA intervention. Then in 2011, they interviewed 209 primary teachers and 87 secondary teachers who participated in EIA's TPD programme. The assessments were carried out by individual diagnostic interviews, assessing competence in English against the Trinity 'Graded Examinations in Spoken English' (GESE) scale .The GESE scale maps against the Common European Framework (CEF); CEF level A1=GESE level 2; CEF A2=GESE 3-4; CEF B1=GESE 5. Trinity's RME shows a statistical improvement of primary (Figure 7) and secondary teachers' (Figure 8) English language competence.

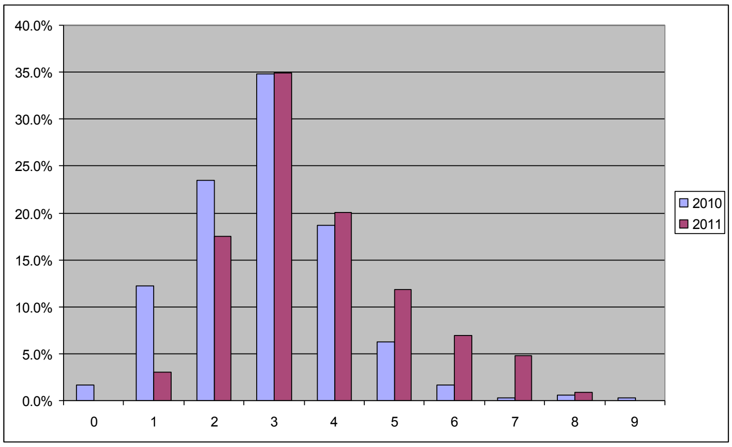

Figure 7: English language competence (Trinity grade) of primary teachers in 2010 and 2011

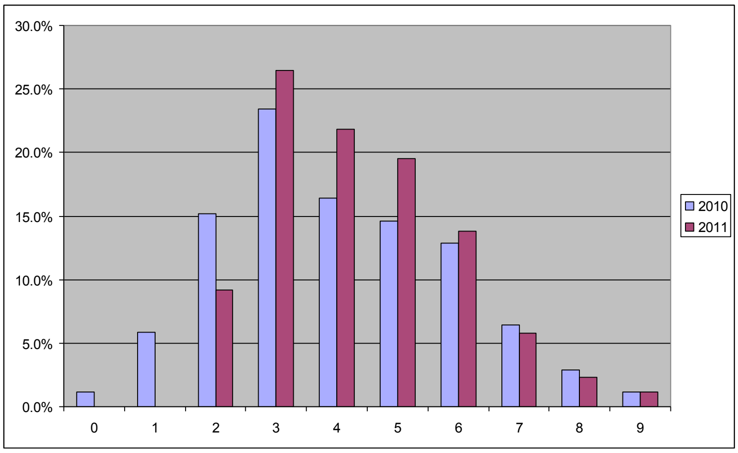

Figure 8: English language competence (Trinity grade) of secondary teachers in 2010 and 2011

From Figure 7, it can be seen that the percentages of primary teachers scoring in the lower GESE levels (0,1,2) fell by approximately 20% in the post-test samples, whereas the percentages of teachers scoring higher levels (4,5,6,7) rose by a similar amount, with increases being spread across the range of higher levels. The pattern for secondary teachers (Figure 8) is similar. In each phase, a general improvement in teachers' English language competence scores can be seen, almost irrespective of the teachers' starting point: there is a general shift of the distribution curves to the higher levels of the GESE assessment.

In 2010, Trinity assessors carried out diagnostic interviews to assess 4630 primary and 2609 secondary pupils' English language competence before their teachers participated in EIA's TPD programme. Then in 2011, Trinity assessed 786 primary and 318 secondary pupils from the 2010 cohort. For primary pupils, prior to EIA, 64.3 % of pupils failed to pass the Trinity's graded examination (Figure 9). In 2011, that number dropped to 49.9%, a substantial decrease. In 2010 35.4% of the pupils scored initial levels (passing) levels of English language competency and this number rose to 50.1% in 2011, a substantial increase (Figure 9).

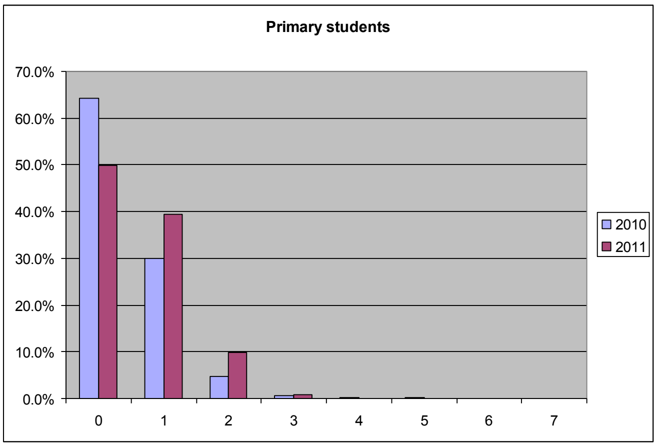

Figure 9: primary pupil English language competency (Trinity grade) in 2010 and 2011

In secondary while the proportion of pupils who failed (below grade 1) dropped from 28.9% to 10.4 % in 2011, the number of pupils who passed at the initial levels (grades 1-3) rose from 61.9% to 66.6 %. Pupils passing at the elementary level (grade 4-6) rose from 9.2% to 22.4 % another considerable increase (Figure 10).

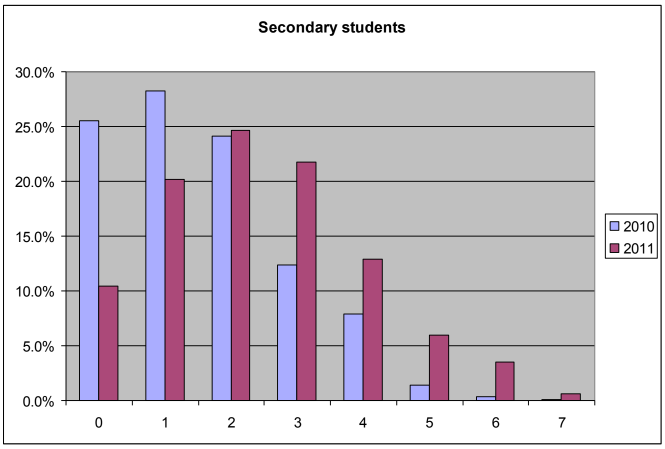

Figure 10: secondary pupil English language competency (Trinity grade) in 2010 and 2011

EIA's TPD model, through this evaluation, has proven to be successful at encouraging higher percentages of teachers and pupils to speak English in the classroom. Additionally, the Trinity research indicates that teachers and pupils have acquired higher levels of communicative (speaking and listening) English language competency after participating in the project for one year.

CONCLUSION

EIA's new model of TPD—which uses mobile devices as tools for delivering professional development and classroom materials—is assisting teachers to learn and apply their communicative English language learning in the classrooms, schools and communities where they work—at scale. Through supported school-based Open and Distance Learning (ODL) using mobile phones and portable rechargeable speakers with all of EIA materials and resources contained on micro SD cards, RME suggests EIA project classrooms are being transformed into vibrant sites of communicative learning where both teachers and students are acquiring higher levels of English language competency.

EIA's TPD programme will support 80,000 teachers in working collaboratively to initiate, trial and reflect upon new English communicative language teaching practices with the goal of adapting and embodying these strategies in their professional practice. They will continue to be supported in this by their peers (in school, and in local networks inside and beyond their school), and through the materials (print, audio & visual) and tools (mobile phones) provided. This is because it is not a model of TPD that is delivered through traditional ODL (self study), nor is it traditional teacher training in which the training and support is offered at a centre that is physically and conceptually 'distant' from the teachers' context of practice—their classroom. Rather it is dynamic, generative and leverages teachers' use of their mobile phones by providing a rich bank of audio and film resources that can be used for self-study and English classroom teaching regardless of time, place or location.

EIA's TPD encourages continuous self and supported learning using low-cost Nokia C1-01 alphanumeric mobile phones that support micro SD cards. Drawing on Government of Bangladesh's Prime Mister's Office's 'Digital Bangladesh' and 'Vision 2021', EIA's goal is to develop a sustainable model of providing English language as a tool for better access to the world economy. We argue incorporating mobile phones within a robust TPD programme presents new opportunities for teachers and pupils to acquire English to levels that enable them to participate more fully in economic and social opportunities. We have observed successful and existing classroom contexts in remote areas that demonstrate the potential of using EIA's resources on mobile devices with lightweight portable speakers. This highlights how mobile phones, as a tool, can change learning and even individuals' livelihoods.

Importantly, EIA is not relying on the internet or the network aspect of mobile phones, but rather that possibilities of incorporating them into large scale targeted TPD with complementary audio and visual resources to improve English classroom teaching and learning in a developing economy. All of EIA's resources fit onto a 4GB micro SD card that currently costs about £1. In 2015 when the project begins to embed in the final phase, the cost of this technology will be even cheaper. It is anticipated that in this phase EIA will design a flexible and institutionalised model that will enable the Government of Bangladesh to be in control and implement EIA's innovative model by themselves and on a continuous basis.

However in order to gather stronger evidence of the impact of use of such technologies in often resource constrained education systems in developing countries and when used as part of a blended approach to TPD, there is clearly a need for further research. EIA will continue to actively design and conduct such research studies as part of its RME Strategy in order to contribute to this often under researched area.

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MobiDics: Cooperative Mobile E-Learning for Teachers

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ABSTRACT

We report on *MobiDics*, a mobile learning platform for professors, lecturers and tutors. In a survey with 100+ participants, we revealed that young, inexperienced teaching personnel at universities rarely use specific didactic methods to plan and structure courses. Such methods play an important role in learning processes since they, for example, activate students and contribute to more profound and sustainable learning experiences. Based on learning phases and social forms, *MobiDics* is able to suggest didactic methods that are adequate to a specific teaching situation. Parameters such as class size, teaching tool support, room constraints, etc. can additionally be incorporated. Learning settings can thereby be formalized and reconstructed based on the building blocks in form of didactic methods.

MobiDics encourages and supports the targeted use of didactic concepts with the long-term goal of increasing the quality of university education. A particular focus lies on cooperative learning through community-based features. Users report on their experiences how well certain methods worked by a commenting function, and exchange tips and feedback with peers and experts. While user-generated content can comfortably be added through the web frontend, a mobile application allows dynamic adaption of didactic planning to contextual conditions such as the current lecture hall.

In a two-step evaluation, *MobiDics* was adopted positively in the target group and its features highly appreciated. Our results motivate a further long-term study where we will evaluate *MobiDics* in the field.

Author Keywords

E-learning, m-learning, didactic toolbox, academic, teacher support

INTRODUCTION AND MOTIVATION

Computer-supported learning (e-learning) is meanwhile an established component in school and university teaching, and used as a complement to traditional, "offline" learning. Such combinations are referred to as *blended* or *hybrid* learning (Martyn, 2003). The risk is, however, that educational games, e-learning and simulations in learning contexts replace a didactically grounded course preparation (Glusac et al, 2007). Teachers still need a profound didactic knowledge to develop learning concepts and to structure their courses, be it offline, online or any combination of them (Ramsden, 2003).

In many countries, university courses are not held by dedicated, full-time lecturers, but by associates without explicit didactic education or PhD students (Winteler, 2001). Such personnel often have little teaching experience and often a limited didactic knowledge, which was confirmed by the results from a survey we conducted with more than 100 people involved in university teaching. We therefore argue for increased awareness for didactically profound course preparation, and for tools that provide teachers with the necessary didactic knowledge to manage this task.

We address this problem with *MobiDics* ("Mobile Didactics"), "a didactics toolbox for the pocket". *MobiDics* is a mobile e-learning platform aiming at university teaching personnel. Both available mobile learning apps on the market and currently ongoing research focus mainly on learners, i.e. students. With our work, we address teachers and lecturers at universities. Based on the knowledge they acquire when using our system, they can improve their lessons, from which, in turn, the students benefit. Of course, teachers in that context can be seen as learners as well. The system encourages the use of didactic methods, adapted to a particular teaching situation. It thus goes not towards blended or online learning like other student e-learning platforms, but explicitly focuses on improving learning in classic classroom settings. We see our tool as a connecting link between mobile e-learning systems and traditional offline learning.

In this paper, we report on our development of the *MobiDics* platform, consisting of a server, a web application and a mobile application for the smartphone. We outline the state of the art in mobile learning and motivate our system by results of an online survey we conducted with professors, lecturers, PhD students and didactic professionals. We gained insights about information sources for lecture preparation and associated problems. Afterwards, we present our *MobiDics* system and describe its features and implementation. The last part discusses evaluation results and future work.

SURVEY OF DEMAND

In order to lay the basis for target-oriented development of mobile learning applications, we conducted an online survey with 103 people involved in university teaching – mainly PhD students (43%), lecturers, professors, etc. (Möller et al., 2011b). Our goal was the assessment of demand for tools supporting them in course preparation. We also evaluated general smartphone usage in the target group to find out whether a mobile application has the potential of being applied. Data on that specific group had so far not been available. Furthermore, we asked for their problems with lecture preparation, consideration of didactic methods, and whether people were satisfied with their current lecture preparation from a didactic point of view.

Method and Participants

The survey was conducted using an online questionnaire. Participants were recruited from didactics courses at the Centre for Higher Education associated with our university (Carl-von-Linde-Akademie). 53 participants were female, 50 were male; the average age was 32.9 years (standard deviation=8.8).

Results and Implications

92% of the survey participants are smartphone owners and use it regularly. After email (92%), information search was the second most widely performed activity on the smartphone (79% of smartphone users). These numbers show that the technical basis for mobile didactics (smartphone coverage) is available in the target group. They also indicate that the smartphone usage for information research and consumption (thereby also potentially on didactics), seems adequate for the target group. Asked about their course preparation, a considerable number of subjects stated in the free text answer field that they rarely used specific didactic methods. We identified the following main reasons for spare usage of didactic methods based on subjects' answers:

- They miss substantiated knowledge about which didactic methods exist
- Subjects have too little experience in teaching and the appropriate use of didactic methods
- The preparation time for courses and lectures is limited, especially for active researchers besides teaching
- They lack feedback on the success of didactic methods; course preparation becomes a cost-benefit calculation (how much time to elaborate a new concept is it worth, if the benefit is unknown?)

Currently, teachers gather information about didactic methods through the internet, books, colleagues and advanced training courses. With *MobiDics*, we address the problems identified in the survey, as it provides the educational background of didactic methods, suggestions tailored to personal teaching needs, and feedback about successful methods usage from other lecturers, as well as from professionals (see also Möller et al., 2011b). The fact that especially young people are potential *MobiDics* users adds to the long-lasting impact of our system.

BACKGROUND

Computer-supported learning (e-learning) has become mature (for an overview of technologies sees e.g. Zhang et al, 2003) and has moved from research labs to the field, e.g. the Moodle e-learning platform (Moodle, 2012). Learning on mobile devices is recently explored more extensively with the rise of tablets, handhelds and smartphones. Thereby the new field of m-learning is defined (Sharples, 2000; Tatar et al., 2003). Those devices allow using learning materials on the go, such as lecture notes in PDF format or podcasts. They facilitate time- and location-independent learning, e.g. on journeys or outdoors. Infrastructures like iTunes U[1] facilitate the distribution and download of digital educational resources or even complete online courses. Beyond that, digital market places, such as the Apple App Store or Google Play (formerly Android Market), offer apps that are targeted at specific learning tasks and contexts. They range goes from vocabulary trainers to simulations and educational games. Mobile learning applications are also suitable for experience-based learning in mobile contexts, e.g. in the medical area (Sharples, 2000; Holzinger et al., 2005), apprenticeships (Tatar et al., 2003), and they can be used for lifelong learning (Pham-Nguyen et al., 2008). Besides offline learning and conventional e-learning, mobile learning is an additional way of accessing resources and acquiring knowledge. This is supported by the possibility of the mobile app to suggest didactic methods e.g. based on user preferences or user or lecture context, such as the configuration of the lecture room. This information can e.g. be retrieved from a university campus information system based on device positioning using e.g. WLAN signals indoors (Kranz, 2010). Its increased flexibility in time and location opens up new learning scenarios, in which traditional e-learning material is not or only in a limited way accessible.

MLE (Mobile Learning Engine) is an extension of Moodle for mobile devices (Holzinger et al., 2005). The original Moodle system[2], which is meanwhile quite established as e-learning platform on many universities, offers online e-tests and learning units as complement to traditional courses. In MLE, so-called MILOs (Mobile Interactive Learning Objects)

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[1] Apple. iTunes U. http://www.apple.com/education/itunes-u/. Last visited May 24, 2012.

[2] Moodle. http://www.moodle.org. Last visited May 28, 2012.

adapts this functionality for mobile devices. MILOs contain small pieces of information, e.g. text, images, questions or multimedia elements. This chunk structure shall foster explorative learning where the learner can choose the amount and order of units. In addition, interrupting and continuing learning, which is typical for mobile settings, is better supported. Self-organization of learning content is seen as an additional motivational factor. However, the lack of a predefined learning path makes the system probably not appropriate for beginners. A further extension of this system are XLOs (X-Media Learning Objects), which make the learning content accessible on a greater variety of devices, e.g. MP3 players, PDAs or TVs (Holzinger et al, 2006). They thereby transport the idea of "pervasive learning": learning can take place at every location at every time, and content is seamlessly accessible over heterogeneous devices.

The heterogeneity of learning tools not only comprises their size (from the small smartphone to the large television set), but also the involved senses. Multimodal learning includes more than one single information channel; it combines e.g. vision, sound and haptic experience. The learning process thereby becomes more sustained, but also more playful, which increases fun while learning (Holleis et al., 2006, Vodvarsky et al., 2007, Leichtenstern et al., 2007). Such multimodal learning systems can be created by enhancing physical objects with digital technology and thereby combining them with the advantages of e-learning. These so-called "smart" or "tangible" objects allow situational and playful learning by experimentation. An Example is the SensorVirrig (Schmidt, 2004), a cushion with integrated ball switches, a compass and a pressure sensor, that can be used to control objects in learning games, or the display cube (Terrenghi et al., 2006) as a playful interaction device for kids. Besides "pervasive learning" at home or other places, such smart objects could also be used at schools or universities and enhance traditional lessons.

Existing e-learning and m-learning systems focus on tools, but not on the methodology of learning concepts that are appropriate from a didactic point of view. Hence, existing didactic knowledge is required for using these tools. Information on the didactic background of tool support, course structuring and knowledge transfer can be found online in form of wikis or training videos. However, to our knowledge no e-learning or m-learning tool includes didactic background knowledge for university education.

MOBIDICS – A MOBILE DIDACTICS TOOLBOX

MobiDics supports the preparation, structuration and execution of university courses on mobile platforms. It is thereby an e-learning/m-learning system targeted at people involved in teaching, with the goal of increasing satisfaction with teachers and improving the quality of education (Möller et al., 2011a; Möller et al., 2011b). We here report on our iterative design of the initial prototype we have presented in our previous work. In the following, we will describe the didactic content, functionality and implementation of *MobiDics*.

Didactic Methods

The learning content in *MobiDics* consists of a collection of didactic methods, which represent a classic link between didactic background concepts and the formulated educational goals in class. Well-considered use of specific didactic methods plays an important role in learning processes (Light et al., 2009; Ramsden, 2003). Such methods can, for example, activate students and contribute to more profound and sustainable learning experiences (Fink, 2003). At the university, where lessons and individual units are often longer and comprise more content than at schools, didactic methods have high relevance. They can support individual learning phases (e.g. knowledge transfer, repetition, assurance of understanding) and thus increase the effectiveness of university education.

The methods we consider have been provided by PROFiL[3], Sprachraum[4] and the Centre for Learning and Teaching in Higher Education (Carl-von-Linde-Akademie/ProLehre[5]) which are professional training institutions at Technische Universität München and Ludwig-Maximilians-Universität Munich. The *MobiDics* database currently contains about 50 didactic methods and is continuously growing.

Learning goals at the university often have a cognitive character. In order to apply the acquired knowledge, often additional social and affective goals are required (Fink, 2003). In *MobiDics*, didactic methods are organized based on ARIVA, a classification that supports multiple of these goals. The scheme has been developed at TU Zurich (Kiel, 2008, p. 30ff) and classifies didactic methods according to the learning phase it which they can be applied. The ARIVA scheme comprises five phases:

- Alignment: Introduction and motivation of the learning content, creation of attention, match with the learner's world and experiences
- Reactivation: Activation of previous knowledge to provide a link for embedding the new learning content
- Information: Active or passive knowledge acquisition, conveying of the learning content

[3] http://www.profil.uni-muenchen.de. Last visited May 24, 2012.

[4] http://www.sprachraum.lmu.de.Last visited May 24, 2012.

[5] http://www.cvl-a.de.Last visited May 24, 2012.

- Processing: Deeper, more extensive and reflective processing of the content, e.g. by answering additional questions, integrating the learned content in larger contexts
- Analysis: Rehearsal of the learned content, answering of open questions that might have occurred in the processing phase, meta-analysis of the learning methodology.

In *MobiDics*, we combine these phases with different social forms, such as work in pairs, small groups of three/four/five people, discussion in the plenum (entire class), or didactic teaching (class is listening). The result is a two-dimensional matrix for method classification, e.g. group work methods suitable for the reactivation phase, or plenum methods for the analysis phase. Since each method already incorporates an educational goal through this classification, teachers can use them to create learning situations that are appropriate for their needs. At the same time, they create a sustained learning experience, as all methods are didactically well founded. Since methods also incorporate the form of cooperation of lecturer and students, as well as of students between each other, changes between social forms (e.g. alternating plenum and group work phases) support the maintenance of attention over longer periods of time. Learning settings can thereby be formalized along the structured dimensions of social form and learning phase, and can be reconstructed based on the building blocks in form of didactic methods.

Functionality

The features in *MobiDics* follow the four paradigms of *Everywhere Use, Better Understanding, Context Sensitivity* and *Pervasive Cooperation* (Möller et al, 2011a). In more detail, the system supports the features described in the following.

Method Management

The entire catalogue of didactic methods can be browsed by name, ratings, actuality, and frequency of use or relevance. Relevance is hereby calculated from both the number and recency of method access (similar to auto-complete suggestions in the browser address bar). The rankings do not only contain own usage statistics, but also incorporate data from other *MobiDics* users, so that users can see what methods are popular with peers. Methods can be rated and marked as favorites, so that every user can create their own collection of personally valuable methods for their own courses.

The didactic methods are available on the *MobiDics* server and synchronize with the client application. The entire content is, after the first synchronization, also available locally and without active internet connection. This enables the entirely mobile use of the system also at areas without connectivity. All local changes are synchronized the next time when a connection is available, either WLAN or UMTS, based on the user's preferences.

Didactic methods comprise extensive descriptions of their appropriate and correct execution. They include examples and ideas for the practical implementation of the method "model", tips from didactic experts and potential problems (e.g. what to do when students are not participating as intended). Besides the initial organization along the dimensions of social form and learning phase according to the ARIVA scheme, each didactic method contains information on the ideal group size (is it suitable for larger lectures with 300 participants or only for smaller lab courses with 10 students?), the expected time needed, material that is required or optional (e.g. a flip chart, paper, a ball) and more. All this information is organized in searchable fields, enabling to perform very detailed searches using logical operators (AND, OR, NOT) and quantifiers (more than, less than). For example, it is easy to find methods for the reactivation phase, applicable for courses with more than 50 students that do not take more than 20 minutes.

Explanations

The usage of e-learning to communicate didactic methods enables a new level of explanations. Group work and games can be illustrated with animations and videos. Self-learning phases or group phases involving varying constellations of students can be simulated and evaluated on the device. *MobiDics* therefore contains a "gallery mode" in which multimedia elements (images, videos, animations) as enhancements for the selected didactic method are available. Methods can additionally link to external resources such as Flash applications or interactive simulations to allow further look into the matter.

Collaborative Learning and Exchange of Experience

Collaborative learning has been proven as effective in the "real world", but is not yet naturally included in e-learning applications. We believe that learning from the experience of others is a central factor of learning success. The big advantage of e-learning is the simplicity to find people with similar interests or level of knowledge out of a large user basis, compared to a class where students often have different previous knowledge (especially in professional education). This is why we included a number of collaborative features to *MobiDics*, such as a community feature for peer exchange.

Users can share their own didactic methods and add them as new entries to the system. This user-generated content is then browseable and searchable just as the editorial content. The only difference is a small symbol that allows other users to identify such methods as user-generated content, since the quality and didactic success cannot be guaranteed. Still, we did not want to implement a quality control instance in form of an editorial team that continuously filters and checks new submissions before making them publicly available. The idea behind *MobiDics* is an platform to which every interested and committed person can contribute, be it the senior professor or the student tutor with only one year of experience.

Instead, we included a rating system that allows users to evaluate the quality of user-generated content themselves. A didactic method can receive a rating from 1 to 5 stars, which also influences the method order in the main screen when the sorting by rating is enabled. The rating is also used for the order of search results when methods would otherwise have the same level of adequacy. User ratings are thereby a democratic, implicit method of "pushing" qualitatively high content to users.

Besides overall quality control, ratings have the function of determining the adequacy of methods for specific subjects and disciplines. Teachers will rate methods better when they used them successfully in their courses. Sure enough, people will rate methods not objectively, but according to their own perceived utility: A certain didactic method that is suitable for a social science seminar might not be appropriate for a math tutorial. A method suitable for a 20-person lab course might not be applicable in a computer science freshman lecture with 500 students. As a consequence, the social scientist will rate methods differently than the mathematician and the lab course tutor differently than the professor.

We see this subjectivity of ratings as an additional chance for *MobiDics*. The old problem of learning didactic methods with books is that they are generic. In particular less experienced tutors will be uncertain whether a described method is actually applicable for their subject and teaching situation. *MobiDics* partly solves this problem already with the filter search, which allows limiting method choices to learning settings, such as "lab course with less than 20 participants". Ratings in combination with a search filter on disciplines now even allow verifying the adequacy for one's own subject: All users who rate a method have a user profile in which they specified their discipline. That way, *MobiDics* can use statistical information on ratings to find out the amount of ratings of a certain subject, faculty, or scientific direction (e.g. life sciences, engineering, and social sciences). The information that most people who rated a didactic method with more than 3 stars were engineers tells with certain reliability that this didactic method is suitable for engineering courses.

As an additional step on top of the user-generated content and rating system, we added a function for commenting methods. Besides the anonymous, fixed-scale ratings, users can report on their experiences with a specific method in detail using a free text field. This opens up the space for discussion and exchange. Teachers can not only describe the effectiveness of a method in a specific context of use, but also directly address problems and potential solutions. The feedback of colleagues and peers can likewise bear great potential, since they have probably experienced similar problems in their own courses and can now share their advice. Last but not least, didactic professionals can hook into the discussion and provide their professional view or provide additional tips and tricks. Users can reply on particular comments, creating a nested structure similar to a discussion board. Comments can, again, be rated with "thumbs up" or "thumbs down" symbol. The ratings can help users to quickly estimate how the quality of a comment was perceived by other users. Besides sorting comments by date, ratings can be used to show high-quality comments on top.

Besides the public sharing of methods, users can also decide to keep their newly added methods private. This allows using *MobiDics* as a personal, privacy-sensitive, readily available toolbox of methods with all advantages of digital search and presence in the pocket.

Context-Sensitive Integration in Teaching and Learning Environments

With *MobiDics*, the user can quickly react on context-specific conditions, such as the room size and equipment. In case of unexpected changes of the room or broken or missing equipment, didactic concepts might have to be revised. For example, the prepared didactic method could require a whiteboard, which is not available in the current lecture hall. The search function in *MobiDics* allows dynamic re-planning of methodical concepts based on the room context.

MobiDics also supports the integration in existing teaching and learning environments such as room management and reservation systems (e.g. TUMOnline[6] at our university). Such databases contain information on room sizes, equipment (e.g. whether chairs can be moved around for group work or whether the room has fixed rows), as well as lecture plans (when does which lecture take place in which room). By an interface to this database, *MobiDics* can dynamically adapt its content to the available facilities for a planned lecture and context-sensitively react on e.g. room changes. Moreover, *MobiDics* can retrieve a location estimate from the phone platform's location provider, so that it can be coupled with an indoor localization service or other location providers implemented on the smartphone.

Multilingualism

MobiDics is designed to support multiple languages seamlessly within one system. The need for multiple languages emerges not only from the fact that many universities offer courses in different languages (e.g. German and English at our university), but also because didactic content is managed best in the original language it has been developed for. Wordings and concepts are often difficult to translate and known under their original terms in the didactic community.

MobiDics users maintain a list of their preferred languages that determines the order in which multilingual content is selected and presented in the user interface. Let's assume a user's preference list is "English, German, Spanish". In that case, for a method available in English and German, the English translation would show up, while a method available in German and Spanish would show up in German. A method only available in French would not be listed at all. Users can

[6] https://campus.tum.de/tumonline

add translations to methods by selecting a language in which the method is not described yet. Numeric fields (such as group size, estimated time, etc.) are automatically copied to the new language, only the translations of the textual fields have to be added.

User Management

Every user of *MobiDics* creates an account with a nick name and additional optional information, such as age, profession (PhD student, tutor, professor, lecturer, …), discipline, courses teaching, experience, etc. This additional information is helpful for estimating the relevance of a user's contribution in search queries. For example, the profession of a user who rated a method can be an indicator for the appropriateness in one's own course, or the comment of an experienced professor might be especially valuable. Users can choose which fields are publicly visible to others to keep their desired level of privacy. This shall encourage e.g. newly appointed faculty members to use the app without the colleagues knowing this and thereby lower the border to use didactic methods in their lectures.

Implementation

The *MobiDics* infrastructure consists of a server, a web interface and a mobile client application, which are illustrated in Figure 1.

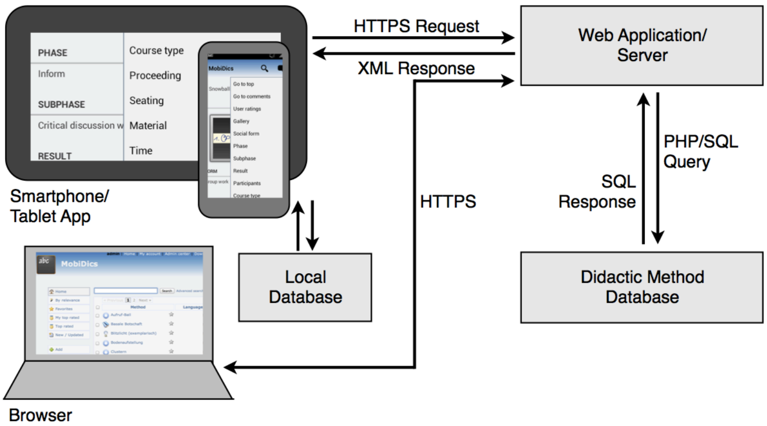

Figure 1. A schematic overview of the MobiDics infrastructure. MobiDics consists of a mobile Android application and a web interface, which both synchronize with the web server and database of didactic methods in the background.

Server

A SQL database holds all methods that are currently available to the system and manages their appearance on user's devices based on language flags and access control information. With SQL queries, even complex searches with multiple conditions can be performed quickly in a large amount of data. The server also manages the user account system. Each time a user starts the local *MobiDics* application or logs into the web interface, she is authenticated with the server and potential changes are synchronized. Synchronization works in two directions: both new methods and comments are downloaded to the client, and local changes are uploaded to the server and delivered to other users. When the client application is used offline, the last synchronized state from a local database is used (a previous authentication must however have been successful to prevent unauthorized access). Changes are then transmitted on the next login. A XML-based data format is used to exchange information with the server and the mobile application. For all traffic between clients and the server a secure connection (HTTPS) is used.

Client

The client application is programmed in Android, thereby supporting a wide variety and a large heterogeneity of devices (smartphones, tablets of different sizes). The user interface is automatically adapted to different screen sizes and ratios for optimal use of the available space. The client implements the platform-typical interaction paradigms such as gesture-based navigation (using a swipe to switch between methods), pinch to zoom, context-sensitive action bar menus etc. for a quick learning curve when interacting with the application and "feeling at home". An incremental search shows results already while typing. Besides automatic content update through synchronization, also the application itself is updated automatically so that entirely new features can be added. The screenshots in Figure 2 illustrate the user interface.

Web Interface

The entire functionality of *MobiDics* is also available in a web application implemented with AJAX. The interface available in the browser allows a more comfortable navigation in non-mobile settings, e.g. in the office or at home, and provides more screen space. It is also the convenient way to enter longer portions of text, e.g. for commenting on methods or uploading own content. The web application communicates with the database using PHP and SQL.

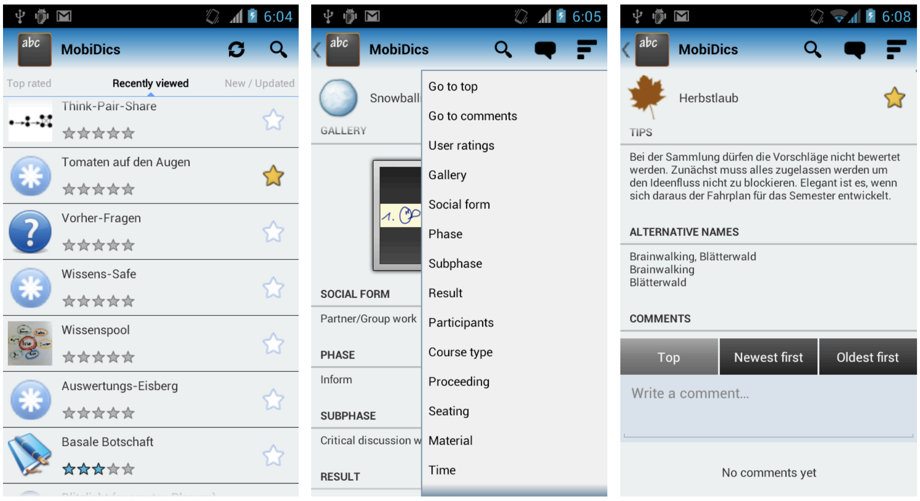

Figure 2: Screenshots of the mobile application. Left: The main menu of didactic methods, sorted by "recently viewed". Middle: The method description view with jump list to different sections. Right: The commenting function for methods.

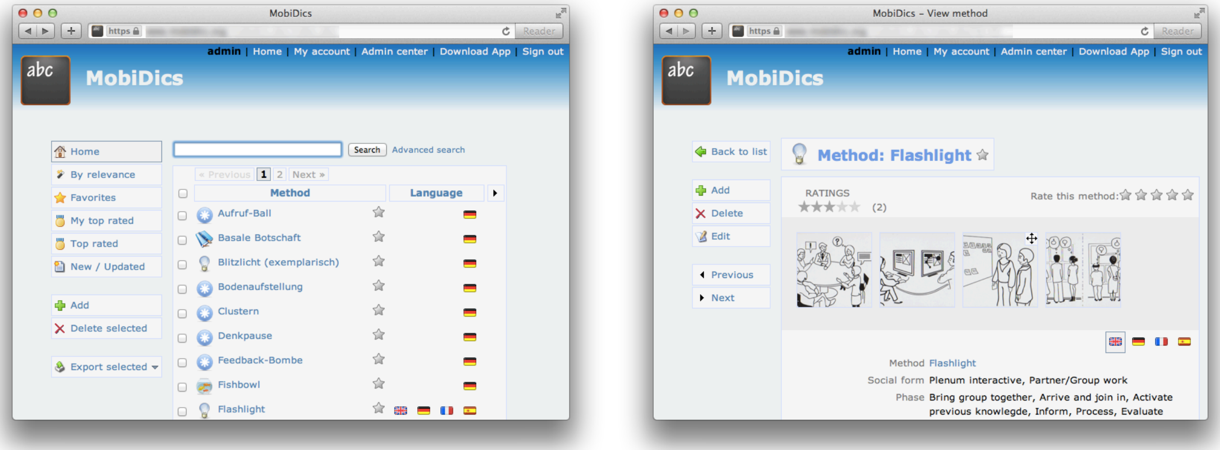

Figure 3: Screenshots of the web interface. Left: The main menu of didactic methods (with language indicators). Right: the detailed description page of a method with multimedia content, such as images or sketches..

DISCUSSION AND FUTURE WORK

We evaluated *MobiDics* in a two-step process. An initial prototype was evaluated online based on a video review (Möller et al., 2011a). We used this assessment for first feedback and estimation whether users would adopt the system. From the 103 users who saw the video demonstration and owned a smartphone, 51% declared that they would use *MobiDics* themselves "likely" or "very likely". Asked for most appealing features, people named the criteria-based search (92%), illustrative multimedia examples (80%) and expert knowledge (63%). People here mentioned particularly features that are not available in traditional information sources. In a second step, the subsequent iteration of the system (as described in this paper) was informally evaluated by a group of users from the target group. Here, particularly the rating function and the ability to comment methods and contributions of others were highly appreciated.

We are aware that *MobiDics* lives from its users and their social interaction within the system. In future work, we are planning to conduct a long-term evaluation in the field. Observations and user feedback how the interactive tools of *MobiDics* (ratings, discussions, new method contributions) are used will hopefully help us to adjust the system to users' needs. In particular, we strive to understand which learning processes *MobiDics* sets in motion through synergies and collaboration between peers. We are also interested in quantitative measurements of improvements of teachers' satisfaction. Another scientific goal is a theoretical formalization of how didactic methods can be classified. The present version of *MobiDics* already integrates alternative names for methods. In the next step, differently described but similar methods should be matched to one and the same method entry (comparable to an alias). Subsequently, we aim to generalize this problem and deduce similarity models for methods, which could then better be matched with the user's profile and interests.

We plan to conduct a long-term study with a larger number of people from different disciplines to gather more insights on the usage and acceptance of the current prototype and to identify future improvements for a release of *MobiDics*.

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The Pedagogy of Mobile Learning In Supporting Distance Learners

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ABSTRACT

The aim of this paper is to investigate the pedagogic approach that best support effective use of cell phones in the distance education context. Many distance education scholars agreed that students need to be supported both cognitively and affectively through mediated forms of interaction. Distance education institutions have used a variety of technologies to enhance interaction but none has been so readily available and accessible as cell phones. The usage of cell phones in supporting students is most suitable in Africa because it is affordable and has the ability to connect less privileged people to information. Despite evidence that show that cell phones can be used successfully as a cognitive delivery tool, the pedagogical affordances of cell phones have not yet been fully explored in most developing countries. To understand the pedagogy for mobile learning, it is important to look at distance education theories to determine the importance of interaction on the efficacy of distance learning. The idea is to map the role of interaction in the distance education transaction with the aim of facilitating and devising pedagogical strategies and techniques that can be used to assist students and lecturers to use cell phones. Therefore, the use of cell phones in teaching and learning should be grounded on sound theoretical and pedagogical principles.

Author Keywords
Distance education theories, interaction, cell phones, pedagogy

INTRODUCTION

One of the main barriers of learning in distance education is the absence of interaction in a learning environment. The distance education character of individual form of learning and the absence of interaction is a challenge for both students who need help and lecturers who want to assist students in cognitive development. The key to the successful enactment of interaction in distance education, "rests on the philosophy of distance education which informs the decisions about techniques and technology" (Evans & Nation, 1989, p.154) and not only on the way the course is presented and delivered. The nature of distance education compels providers to use mediated forms of interaction to support their students. This enables students to communicate with their lectures and talk with each other in an effort to understand the course content. Throughout the history of distance education, theorists and researchers have been concerned with explaining the functioning of the concept of interaction in enhancing and supporting learning in distance education. The idea is to find an accessible and available technological tool that can be used to support distance education students. Studies have shown that students' development is determined by social interaction through problem-solving under the guidance of a teacher or in collaboration with capable peers (Brindley & Paul, 2004; Garrison & Shale 1990; Lave & Wenger, 1991). Mobile technologies, such as cell phones, hold a lot of promise for distance education as a cognitive delivery tool to enhance interactive collaborative learning while addressing the challenge of student isolation which is often associated with the correspondence nature of distance education.

To address the problem of student isolation, distance education institutions, especially in developing countries have used numerous intervention programs such as tutorial support, counseling services and peer-group support to enhance interaction. Where it is not possible to offer face-to-face tutoring, tutoring via telephones, videos and computers have been used to support a two-way communication between the teacher and the learner. It is only recently when other distance education institutions have been used Short Messaging Systems (SMS) to communicate with their students. Most people in developing countries are likely to own a cell phone than any other technology. In South Africa alone, the cell phone penetration is estimated at 98 percent. A recent survey found that 39% of urban South Africans and 27% of rural residents are now browsing the internet from their cell phones (Rao, 2011). Cell phones are more accessible to most rural communities in terms of cost, geographic coverage and ease to use. "Interestingly in Africa, consumers might not have shoes, but they have cell phones", remarked Brian Richardson, a founder of a mobile service company (Rao, 2011). Most communities in Africa including peasant farmers, health workers, migrant labourers, rural extension workers are using cell phones not only for communication purposes, but to carry out their daily business.

More 98 percent of University of South Africa (UNISA) students' already use cell phone for social purposes. Even the low-end cell phones have some software features such as pictures, video, games, instant messaging that can be used for tutoring, assessment and collaboration amongst students and teachers. Some of these features can be harnessed to develop formal learning opportunities for distance education students. Despite evidence that show that cell phones have occupied every facet of our lives, the pedagogical affordances of cell phones have not yet been fully explored in most developing countries. "It is not technologies with inherent pedagogical qualities that are successful in distance education," according to Keegan (2005), "but technologies that are generally available to citizens" (p.3).

Although many technologies have been used in the past to enhance interaction in different types of learning contexts, Simonson et al. (1999) argued that learning through distance is fundamentally different from learning in a classroom setting even when the technologies are used. "Just as a triangle and a square may have the same area shapes, the experiences of the local (classroom) learner and the distant learner should have equivalent value even though these experiences might be very different" (Simonson, 1999, p.71). It is therefore important that the pedagogy that is used to support distance learners should be tailored to the distance education context. What separates distance education from other learning contexts is that students are physically, emotionally and socially separated from their lecturers, their peers and their institution. The problem arises when interaction amongst stakeholders is not as constant as what exists in other learning contexts. Interaction, according to Anderson (2010) is the core of the educational experience and the nature of distance education compels providers to use mediated forms of this interaction to support their students. Without interaction, teaching becomes simply "passing on content as if it were dogmatic truth," (Garrison & Shale 1990, p.29). The aim is to investigate the pedagogic approach that best support effective use of cell phones in a distance education.

This will be done through highlighting some of distance education theories to argue for the principles that guide pedagogy and practice in using cell phones for the purpose of supporting distance education students. The role of theory is “to create conceptual order and provide simplicity in describing complex phenomena” (Garrison, 2000, p.4). The focus will be on distance education theorists who dealt specifically with communication or interaction. These theories will be used to map out the role of interaction in the distance education transaction with the aim of facilitating and devising pedagogical strategies and techniques that can be used to assist distance education students and lecturers to use mobile technologies in the education environment. Anderson (2011) argues that technologies have a major impact on the pedagogy in that “the technology sets the beat and creates the music, while the pedagogy defines the moves” (p.2). Both technology and pedagogy are intertwined and therefore it is important to look at how they work together to support different models of learning.

THEORIES OF INTERACTION IN DISTANCE EDUCATION

To understand the pedagogy for mobile learning, it is important to look at different theories that impact on teaching and learning. Education theories, be it distance or not, leads to an adoption of specific teaching and learning process. Distance education theories were classified into three groups: theories of independence and autonomy, theories of industrialization of teaching, and theories of interaction and communication (Keegan, 1986). Each of these theories was trying to explain the processes and practice of distance education. In most distance education contexts, interaction between the lecturer and the student is done through student sending a completed assignment to the teacher who marks it and sends it back with comments and feedback. This form of interaction was not sufficient for most students who needed much more. An effective support that students were expecting, according to (Brindley & Paul, 2004) should personalize the learning process; encourage and facilitate interaction between students and stakeholders; and facilitate learning within courses. Therefore s study materials and assignments should be designed in such a way that students are encouraged to analyze, summarize and draw conclusions on the content of the study material (Holmberg, 1993). The idea is to establish a personal relationship with the students and course developer and “find ways to non-contiguously cater for something functioning in the way that dialogue does” (Holmberg, 1983, p.69). The real or two-way conversation could be done through the written, personal and telephone interaction.

In distributed learning environments such as distance education, “what is known lies in the interaction between individuals and artifacts, such as computers and other technological devices” (Dabbagh, 2005, p.30). These technologies are used to enhance two-way communication in distance education. Garrison (1989) argues that two-way communication can only be sustained if students are also in control of the educational transaction. His concept of learner control is based on the students’ “ability to influence and direct a course of events” (Garrison, 1989, p.27). The nature of mobile learning is that it supports student centredness which aims to develop in each student a sense of responsibility for his or her own learning by focusing on individual student’s experiences, perspectives, background, interests, capabilities and needs (Pullist, 2001).

The distance education character of individual form of learning is at the centre of some of the problems within this system. The assumption is that distance learners, do not need mediation or support as they go through their learning experience. Many studies revealed that students need mediated conversation between themselves and their teachers as they go through integrated and structured dialogue in the study material and in other interventions aimed at formative development of a student (Holmberg, 1983; Moore, 1993). Moore (1993) argues that distance education, not only a geographic separation between the teachers and the learners, is a pedagogic concept. In this separation there is a “psychological and communications space to be crossed, a space of potential misunderstandings” between instructors and students who are physically separated (Moore, 1993, p.22). To address this transactional distance, Moore (1993) believes that interaction between student and content; student and student; and student and lecturer should be encouraged. “Deep and meaningful formal learning is supported as long as one of the three forms of interaction… is at a high level” (Anderson, 2003). These forms of interaction should be used to promote learning regardless of how students are linked to the resources they require (Simonson et al., 1999).

While Moore looked at interaction from a students’ point of view, Anderson and Garrison (1998) focused on the educational phenomenon of interaction from the multiple-perspectives. They argued that teaching and learning is not only about students, it also includes other forms of interaction that takes place in distance education system. The idea was to clarify the costs between independent-oriented and interactive-oriented learning strategies and activities. Anderson (2010) stressed “the importance of cost and sustainability as well as pedagogical value in choosing appropriate mixes of interaction” in his equivalency theorem framework.

Central to any education experience irrespective where students are studying is mediated interaction (Garrison, 2000). The relationship between the interaction that occurs between the person who is giving instruction and the one who receives it determines the distance between the student and the lecturer (Moore, 1983). Moore (1993) and Garrison (2009) concepts of dialogue, structure and learner autonomy or control are central to two-way communication. The use of technology is an essential component of supporting two-way communication in the education transaction (Garrison, 2009). The idea is use technologies that students are already using and are comfortable with to adapt to formal learning environments. However, the successful implementation of using cell phones is dependent on student and teachers understanding of why they are using it in an educational environment and how they should use it (Hillman, Willis & Gunarwerdena, 1994). Student and teacher need “to operate from a paradigm that includes understanding not only the procedures of working with the interface, but also the reasons why these procedures obtain results” Hillman et al., 1994, p34. It is only when both teachers and students understands why and how they can use cell phones in their learning environment would they be convinced of its potential and educational value.

PEDAGOGY OF MOBILE LEARNING

In trying to understand how mobile technology can be appropriated for teaching and learning at a distance, we should start by looking at how different is mobile learning from other technologies that are used in teaching and learning (Laurillard, 2007). The strength of using mobile technologies is that they offer learning that is intimate, spontaneous, pervasive and versatile. Mobile learning “provides an enhanced cognitive environment in which distance learners can interact with their instructors, their course materials, their physical and the virtual environment” (Koole, 2009, p.38). The difference between mobile learning and other technologies is that it has the ability support situated learning (Kukulsa-Hulme & Traxler, 2005). Mobile learning provides students with opportunities to engage in authentic activities. In this context, students are able to explore, share and interact with each other as they try to learn together in their real life learning environments.

The nature of mobile learning is that it tends to ascribe to the student-centred approach. This pedagogical approach assumes that students come into the learning environment with their own perceptual framework and therefore they need to be encouraged to construct their own meaning by talking and listening to each other, writing and reading as well as reflecting on content. When students are in control of their learning, they are able to link up with other students in collaborative learning networks. Through peer collaboration, according to Laurillard (2007) students are more likely to be motivated to share their work with each other as well as to augment their conceptual understanding with others. In the distance education context, social interaction relates to the socio-emotional aspect of group forming and group dynamics (Kreijens, et al., 2003). UNISA students were able to set-up study-groups through MXit – a cell phone social network system, to help each other through difficult areas of their courses (Makoe, 2010). Mobile learning was able to facilitate this process through building communities of learners who are committed to working together to achieve a goal. "Collaborative learning leads to deeper level learning, critical thinking, shared understanding and long term retention of the learned material" (Kreijins et al., 2003, p.336) as well as developing communication and social skills. The question is how do we harness mobile technological features to support learning?

Studying through printed media will and still remain one of the main medium of instruction in most developing countries such as South Africa. The pre-produced self-contained study material are developed with an explicit understanding that they facilitate access to learning especially to those people who live in marginalised, remote communities. However, several studies have reported that cell phones can be used in conjunction with printed material to support interactive pacing; just-in-time instruction; network databases; interactive prompting; self-check assessment; facilitating summative and formative assessment; problem solving and collaborative learning. The challenge is how distance education providers integrate these activities to enhance the learning experience for distance education students.

Theoretical framework	**Pedagogical focus**	**Uses of cell phones**
Guided didactic conversation Holmberg (1983)	Study material should be written in a personal style; easily accessible; offer explicit advice, suggestions and invite exchange of views. Mediated conversation should facilitate the development of learning relationship between the lecturer and the student	Cell phones can be used in conjunction with printed materials to give and get feedback from lecturers and students; access learning games; simulations; self-assessment quizzes; podcasts and videocasts. Content can be broken into small chunks to make access easier and avoid scrolling.
Transactional distance (Moore,	Learner – lecturer: The lecturer provides an organised curriculum to ensure that the student masters the	A lecturer can send an SMS that is meant to trigger discussion on a particular topic and then encourage

1989; Moore and Kearsley, 1996) Hillman, Willis, and Gunawardena (1994)	content Learner – learner: Students form peer support groups Learner-content: Student reads a book, views or listens to DVDs and CDs and interacts with inanimate learning resources. Learner-interface: interaction between the student and the technologies used to deliver the instruction	students to engage on a discussion. Students can form peer support study groups through cell phone social networks such as MXit, WhatsUp, BBM etc. They can support each other synchronously or asynchronously Student can interact or get clarity on a difficult concept by checking it on the internet using cell phones. Podcasts and videocasts can be created to record, store and deliver content (Anderson, 2010 Lecturers and students can acquire different technological skills and competencies they need to understand and know how to use different mobile features and applications for teaching and learning.
Theory of integration of the teaching and learning acts Keegan, (1990)	The course is designed and developed using networks of diverse applications such as Open Educational Resources (OERs), wikis, blogs, discussion boards, conference sessions, social networks such as Twitter, Skype and podcasts.	Students can be asked to access certain OER material on the internet; and be asked to offer their own ideas and post them in their cell phone social networks where they share them with their peers and lecturers. Students can take pictures, share with others and hold discussions on how to solve a particular problem using different cell phone applications.

Table 1: Theories and the pedagogies that supports the use of cell phones in distance education context.

DISCUSSION

Distance learning, unlike classroom based learning, has always been challenged by the problem lack of communication in the education transaction. That is why distance education theorists have always looked at how to address this problem through mediated technologies and face-to-face intervention. Since cell phones can be used as a tool to facilitate interaction through synchronous and asynchronous learning, it is suggested that different cell phones applications are harnessed for teaching and learning. Students can also be encouraged to use cell phone social networks such as MXit, WhatsUp, BBM to form study groups and work collaboratively on projects. Through these communities students will be able to get together, engage in joint activities and discussions, help each other and share information about the course. Communities develop their practice through problem solving, requests for information, coordination and discussing developments, mapping knowledge and identifying gaps.

In distance education, the process is usually reduced from a dialogue to a monologue where a lecturer sends out pre-packaged study material to students. The assumption is that distance learners, do not need mediation or support as they go through their study material. However, many studies have reported the students need for mediated conversation between themselves and the teacher through integrated and structured dialogue both in the study material and in other interventions aimed at formative development of a student (Holmberg, 1983; Moore, 1983, 1993; Thorpe, 2001). The lack of contact and limited feedback from their lecturers is of great concern for distance education students. Most of them do not have the confidence to learn independently and a result they have trouble in self-evaluation. Students need lecturers to help and support them as they engage with their study material. To keep students motivated, lecturers should send students feedback almost immediately because students rely on lecturers' comments on their assignments and they can also send motivational SMSs. When the lecturer send information via personal and situated devices such as cell phones, students feel supported, they develop a positive relationship with their lecturers and the university and they find learning more pleasurable and this in turn supports their motivation.

Cell phones can also be used to enhance this interaction through weekly self-assessment quizzes where students can test themselves on basic factual information. This will also encourage students to pace themselves as they go through their study material. Cell phone downloadable audio files can also be used to add a voice and provide a narrative to the content. The combination of printed study material, cell phone based self-assessment quizzes and audio can guide a student through the maze of learning material while assisting them to pace themselves.

CONCLUSION

All these theories that have been mentioned in this study were trying to provide direction and new approaches that can be used to bridge the distance associated with the correspondence nature of distance education. It was therefore important to draw from distance education theories in order to understand the pedagogical suitability of using cell phones in enhancing interaction. New technologies such as cell phones provide unique technological attributes that could be harnessed to enhance teaching and learning. These new technologies can be used to support personalised, immediate and situated learning. These features are particularly important in distance education because they can enable interaction between a student and a lecturer as well as between a student and his or her peers thereby addressing the problem of isolation.

Despite reported successes of using cell phones, lecturers in developing countries are not convinced about the mobile learning potential to develop new ways of teaching and learning. The success of using cell phones in education depends on the lecturers' attitudes and how they integrate the use of devices into the learning process. It is only when the teachers understand the pedagogy that supports its use; and they are empowered with the necessary skills; that they will utilise the affordances of mobile technologies to engage and support students in the learning processes.

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Zapp: Learning about the Distant Landscape

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ABSTRACT

A successful application area of mobile technology for learning has been to provide location-based guides that inform students or tourists about their immediate surroundings. In this paper we extend this location-based learning to the distant landscape, so that a visitor to an unfamiliar area can ask "what can I see over there?", or can annotate the landscape by taking photos of distant features and adding text or audio notes that are the automatically located as points on a digital map. We describe a system, named Zapp, for learning about the distant landscape. It uses a line of sight algorithm computed over a digital surface model stored on a smartphone to determine which distant feature is showing in the centre of the smartphone camera screen. In 'query' mode the system can inform the user about pre-stored elements of a landscape such as names of rock formations. In 'capture' mode the user can store a note about a distant feature, linked to a photo and to its map coordinates. A trial of the system with university students has demonstrated its usability and usefulness in interpreting the geology of a rural landscape.

BACKGROUND

Finding out about one's immediate environment is a well-recognised application of mobile learning. This can be achieved through the use of a handheld device with location sensing technology, such as GPS or phone cell positioning, running an application to deliver information in text, audio or multiple media about the user's current location. Examples of such outdoor mobile guides include Cyberguide (Abowd et al., 1996), GUIDE (Cheverst, et al., 2000) and Caerus (Naismith, Sharples & Ting, 2005). See Kray, Baus and Cheverst (2005) for a survey of location-based guides. While there can be problems with accurate positioning, particularly in an urban environment with areas of 'GPS shadow', location-based guides have provided a foundation for research and development in contextual mobile learning. Several research prototypes (e.g. Quinn & Cartwright, 2009; Bradley et al., 2010) have been based on the Mscape platform (Stenton et al., 2007) produced by HP Labs in Bristol to develop mobile media guides and games.

Another approach is to augment the natural landscape with instructional information and stimuli for inquiry learning. The best-known is Ambient Wood (Rogers et al., 2004) where information and instruments were embedded in a woodland for children to carry out investigations into its biological processes.

All these examples assume that the learners are gaining information about their immediate surroundings. But what if they want to learn about a distant object, landmark, or area in the landscape? Some examples of such need include the following: tourists interested in information about visible landmarks such as the names of distant mountain peaks; students on a geology field trip learning about rock formations in the surrounding landscape; visitors to a heritage site exploring how an area looked in historic times; or for general users of camera phones, being able to log one's photographs of distant landscape features on a map to show both the photographer's position and the location of the distant feature.

Current technologies can offer some assistance by two different methods: augmented reality based on device position, orientation and tilt; and image recognition of landmarks. Augmented reality systems such as Layar (http://www.layar.com/) and Wikitude (http://www.wikitude.com/) show information about nearby buildings or landmarks overlaid on the phone camera screen. The problem is that these applications only show what is in the general direction of the camera, not what the user can actually see. If the user's line of sight to a target building or landmark is blocked by another building or object, then this can cause confusion or misinformation. The other approach (with Google Goggles being most widely used example, http://www.google.com/mobile/goggles) uses image recognition software to identify a landmark within a photo taken by the phone camera and then search for relevant information about it. For instance, using Google Goggles to capture an image of the Golden Gate Bridge in San Francisco might return Google search entries for ‘Golden Gate Bridge’ alongside its position on Google Maps. This works well for famous landmarks that fill the viewfinder, but cannot recognize less well-featured parts of a landscape, or landmarks at a distance.

A more widely useful tool for learning about the distant landscape would be a ‘tell what I see’ application that enables a user to point a phone camera at a landscape feature and see or hear information about what is showing on the screen. Additionally, a ‘mark what I see’ application would locate on a map what is shown at the centre of the camera viewfinder, and then allow the user to add information such as a text label or audio description. This is the design aim for the Zapp application.

ZAPP APPLICATION

Figure 1 shows the current user experience of Zapp, in use at the Lake District National Park in the North West of England. The system has two modes, each of which involves just a single button press. In ‘query’ mode, the user moves the camera display screen of an Android phone running the Zapp application until the central cross hairs turn from red to green, and a descriptive text label appears, showing it has detected a known landmark. The user then presses the ‘What is this?’ button and the screen gives a previously prepared multimedia presentation about that landmark. In ‘capture’ mode, the user points the centre of the screen at a distant location, presses the ‘Capture’ button where the coordinates of the distant location are logged as well as a photograph. The system associates that photograph with the location, so that it may be used later for authoring tours, or as part of a response to a query.

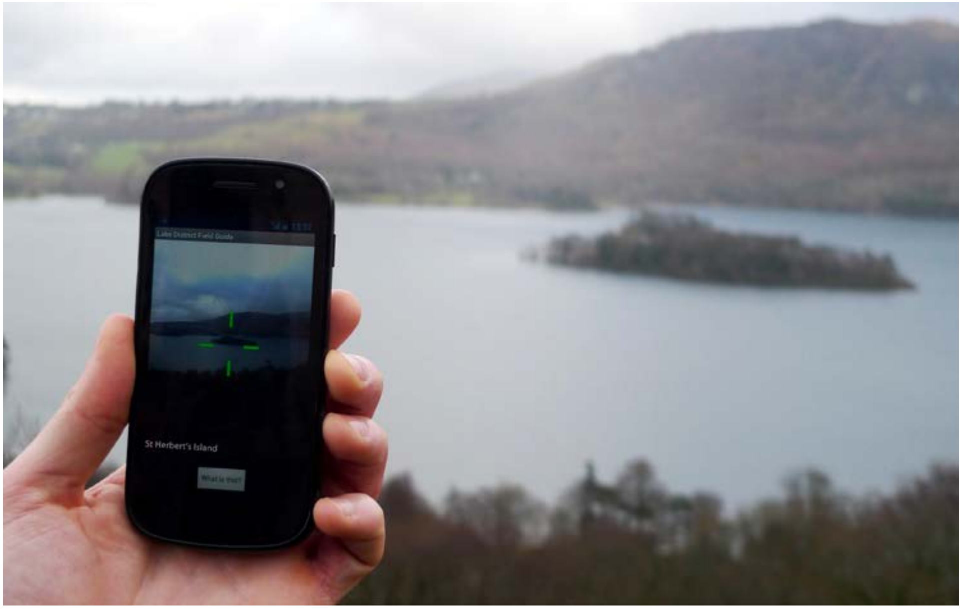

Figure 1. Screen display of the Zapp application, showing it recognizing St Herbert’s Island in Derwent Water

Belying the simple user interface is a complex combination of hardware and software. The entire application must run on the mobile device, since a reliable internet connection cannot be assumed for an outdoor rural location. The device stores a digital surface model (DSM) of the terrain where the application is being used, which might be a city with buildings, or a rural landscape with hills and valleys. The DSM can be provided by airborne laser scanning (Light Detection And Ranging - LiDAR) or as in the case of the Lake District model airborne radar. This matrix of elevation values can be regarded as a ‘Lego block’ representation of the terrain (see Figure 2). For the Zapp Lake District demonstrator, each block represents a 20m by 20m square on the ground (20m resolution), producing an array size of 490,000 cells for the 15km by 15km study area, which can be stored in memory on the mobile device. For more complex terrains (e.g. cityscapes) LiDAR data of higher resolution (2m or finer) covering a smaller area could be used, here the DSM represents the surface ‘canopy’ of trees, buildings and other prominent objects on the ground surface.

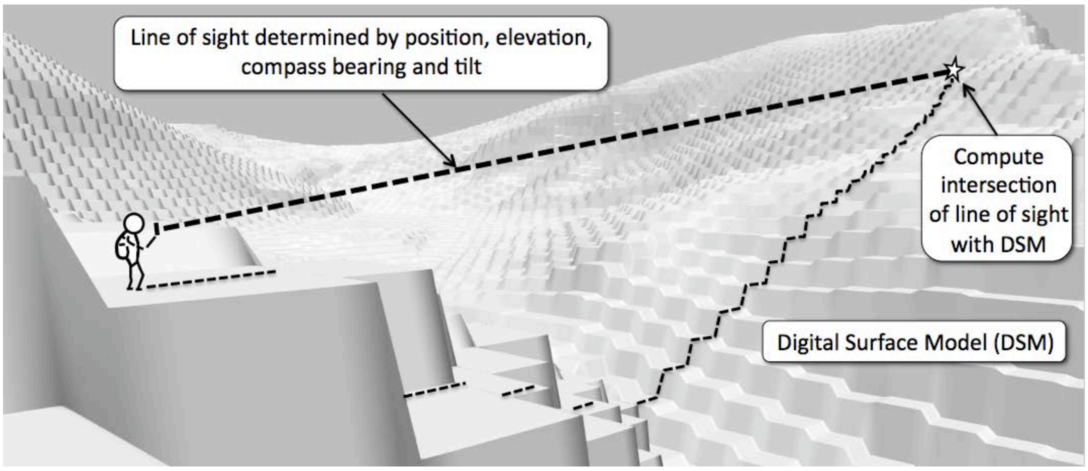

Figure 2. Schematic of computation for the Zapp application

The Zapp application combines this DSM with data from the mobile phone indicating the device's current location (computed from GPS data provided by the device), compass bearing (from the device's inbuilt compass) and tilt (from its tilt sensor). The application then computes the line of sight (LOS) to the distant location using the following method (see also Figure 2[1]):

1. Compute the height of the device, using the GPS data mapped to the surface model (raised by 2m to represent the approximate height of the camera above ground)
2. Using the position, orientation and tilt data, compute a line of sight from the device over the DSM. This is done by iteratively calculating both the height of the line of sight and the height of the DSM cell in the direction the device is pointing, such that:
    a. if the calculated height of the DSM cell is less than the height of the line of sight then go to the next cell, or
    b. if the height of the DSM cell is greater than the height of the line of sight, then this is where the sight line intersects with the terrain, so record its map coordinates as the target location.

Once the map coordinates for the target have been computed, then Zapp opens an interface to play the associated media (in display mode) or record an annotation linked to that map location (in capture mode).

ACCURACY IN THE FIELD

A controlled study was undertaken to test the accuracy of the Zapp system. In brief, the application was tested in the Northern Lake District, in the area to the West of Derwent Water shown in Figure 1. Three researchers walked along a predetermined route and approximately every 100 meters they stopped and captured three salient landscape features, agreed amongst the researchers, of differing sizes and distances using Zapp in 'capture' mode.

In total 468 capture attempts were made, for 22 different landscape targets at 12 locations along the route. Of these, 385 were successfully captured and 83 were missed, with the line of sight being recorded as above the highest point (in Figure 2, for example, it would be recorded as 'missed' if the line of sight was computed as being above the top of the distant mountain). For those points successfully captured, the mean error was calculated for three different types of landscape object: hilltop peaks, defined points, and undefined points. Defined points were easily recognizable features of the landscape, such as the gable end of a specific house. Undefined points were more ambiguous regions of the landscape, such as the centre of St Herbert's Island.

Since the output from the Zapp system in capture mode is the map reference of the captured landscape feature, the location of each attempt can be compared to the actual map location of the landscape feature, to measure the distance error. For example, if a user attempts to log the location of a house in 'capture' mode, the error is calculated as the linear distance between the logged point, as computed by the LOS algorithm, and the actual position of the house on a map. The results showed that defined points were the most accurate, with, for example, the mean distance of the computed location from the actual map reference being 375 meters at a range of 1-2 kilometers. The greatest mean errors were in the location of undefined features and distant mountain peaks. Overall, there was a wide variation in accuracy.

[1] Note that Figure 2 is not to scale, in that each DSM cell is much larger (20m width) than the user.

Some reasons for the errors include: camera wobble when the user is capturing a point with the handheld device; seeing a flat mountain top from a low angle so the perceived peak appears closer than the actual peak; and an artifact of the ‘Lego block’ DSM where the edge of a nearby terrain element falsely obscures the computed line of sight. Each of these could be addressed in different ways: by resting the camera on a tripod or surface or capturing multiple points; by having a ‘snap to fit’ to the nearest salient map feature; and by the algorithm ignoring the ‘blocking effect’ of nearby DSM cells in the terrain model. These improvements will be explored in future versions of Zapp.

The field testing helped to define the level of accuracy that was currently possible with Zapp in terms of the size of features of interest that could be queried. This knowledge helped to shape a field exercise designed to explore the use of Zapp to support undergraduate students of Geography in learning about the formation of the physical landscape in the Lake District.

FIELD TRIAL OF THE ZAPP SYSTEM

One aspect of Geography fieldwork in an area such as the Lake District is to foster an understanding of how various factors have shaped the landscape students can see around them. This includes the influence of sub-surface geology on the shape and texture of landforms at a range of scales. The skills associated with learning about such relationships include the ability to interpret geology maps and relate them to the three dimensional landscape. As with many aspects of geography fieldwork this requires careful observation of the landscape at a range of distances from the observer. The process of in-field interpretation may on occasions be supported by a knowledgeable human field guide, but sometimes students working independently or in small groups may not have the opportunity to get on-demand expert confirmation of their observations. On previous field exercises to this area, the students were given paper sheets with 3D views showing geology maps draped over a digital model, as illustrated in Figure 3, however these related to only a few key stopping points for which panoramas were pre-generated. An exercise was therefore developed therefore to test the use of Zapp for the query of distant landscape features, in this case areas of ground underlain by various types of rock and sediment.

Figure 3. Geology draped over a digital model as used in previous field exercises

Features of interest authored for use by Zapp can be assigned any size or shape of area on the map. The earlier field testing had suggested that at distances of one to five kilometers the application was not sufficiently accurate to inform about features smaller than approximately 200 metres in width. In the case of geology there is continuous map coverage of rock and sediment types for the area, at a range of scales and levels of classification, so we had the opportunity to create sets of zones that were large enough to be usable by Zapp.

Digital geological data created by the British Geological Survey was processed in the Geographical Information System (GIS) ArcGIS, reclassifying sets of digital aerial feature (polygons) for both solid rock geology and surface deposits to produce a combined map showing the dominant surface rock or sediment type for broad areas of the landscape. For use in Zapp this was converted to an array of values representing geology type, such that any distant location queried by the application would produce a mixed-media description of that rock or sediment type. In this case, areas adjoined each other forming a contiguous coverage, with many areas sharing the same geology type. For other applications of Zapp (such as describing specific landmarks) there could be separate areas of interest each with its own unique properties relating to a particular location. Figure 4 shows the geology zones used for this exercise along with an example of the teaching material for one zone. Whilst Zapp had the ability to serve audio and video, for the purposes of this exercise the style of media used for all zones was consistent, being a combination of summary text and image.

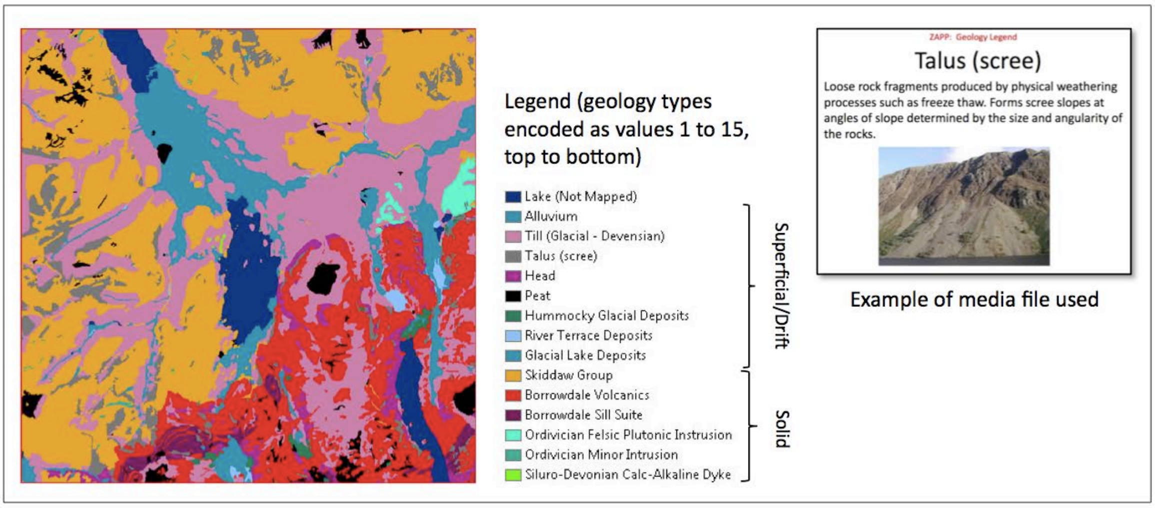

Figure 4. Geology zones and example teaching content for the Zapp application

The exercise was part of a three-day residential Geography field trip for first year undergraduate students, forming one of several optional day projects, with 19 students choosing to take part. The main learning objective was to account for the physical landscape around the study area shown in Figure 4. This area has undergone periods of geological uplifts which have created the differences in topography and periods of glaciations, carving out the landscape and producing its iconic views. More recently, parts of the landscape in the area of study have experienced human intervention in the form of visually salient pasture land and wood plantation. Geologically, one of the reasons the study area is suited to this kind of student inquiry is its wide variety of rock types within a small geographic region. The Borrowdale volcanics are a set of rock types characterised by their ruggedness and resistance to weathering, shown in Figure 4; the Skiddaw Slates are softer rocks, more weathered and therefore less rugged. Features associated with these rock types can be seen in the landscape with various levels of visibility. The students were asked to gather evidence from the landscape in order to produce a geological story of the landscape with observed examples.

The 19 students were split into three groups of roughly equal numbers for each of the two runs of the project. They were given time in the field centre prior to their field work to prepare for the trip, using provided materials to understand a little about the geological history of the area and to get used to using Zapp around the field centre which was conveniently located within the study area. In addition to Zapp, the students were provided with paper geology maps of the area, cameras to produce still and video logs of their learning activities, and field workbooks for sketches and notes. After their preparation, the students were taken to the bottom of Catbells Fell, as when climbed it offers views of varied rock types. Whilst in the field, the students were encouraged to use Zapp to capture a large set of data points of features in the landscape which provide evidence for the geological history of the area, to be analysed later at the field centre and organized into a story. Over the two runs of the project the students captured a total of 293 points using Zapp (Figure 5).

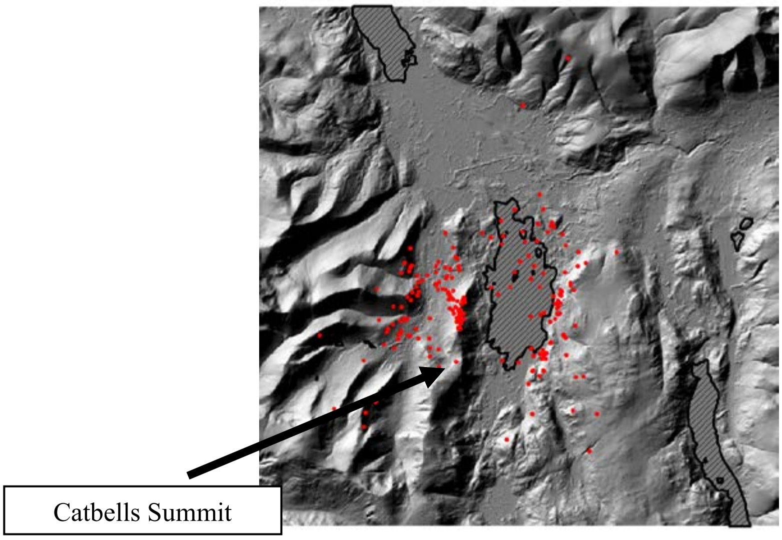

Figure 5. Points captured with Zapp by the student groups, bodies of water shown in crosshatching

ZAPP AS A FEATURE RECOGNITION AID

During the geography field trip, the students used Zapp as both a data logging mechanism and a querying tool. With the application in ‘query’ mode, the students were able to point the screen at any part of the landscape in view and press the ‘What is this?’ button. Then, the application displayed information about the underlying geology of the landscape in the form of a standardized slide which contained an image and some peripheral information about the piece of landscape they were viewing.

As the students were being assessed on their production of a media rich PowerPoint presentation, they also used Zapp to collect examples of geological features in the landscape. To do this, the students switched the application to ‘capture’ mode using a standard menu option. In this mode, the crosshairs on the screen are blue and do not change colour when sweeping over a point of interest. When the user sees a POI they wish to capture, they align the crosshairs with that POI and press the ‘Capture’ button. Zapp then activates the LOS algorithm to log the coordinates of the POI and simultaneously stores the image on the screen as a photograph. The coordinates of the POI, the device location, its compass bearing and its tilt are all logged to a text file stored on the device. The POIs can be plotted later on a digital map and a numbering system within the file allows for easy lookup between the photographs and the logged data.

After the students finished their time in the field they could access both the photographs and the log data at the field centre. They then used some of the data from Zapp to construct their media rich PowerPoint presentations for assessment. Several groups also plotted the points they had captured on a 3D model of the landscape, to further explain their findings.

The researchers gained information about student use of the Zapp application from direct observation of the students, from viewing the video recordings made by the students as logs of their learning activity, from the data points and images captured by the student groups, and from items in their assessed presentations that reported their impressions of the Zapp application. Due to the students’ prior knowledge of physical geography and their time in preparation, they had grounding in the kinds of features they would be looking for in the landscape. When Zapp was being used in ‘query’ mode as a feature recognition aid, the students tended to identify something in the landscape which could be a feature of interest, then point the Zapp screen at the feature to see if the result tallied with their expectations. This checking activity generally occurred for very large features, such as a range of Borrowdale volcanic rocks.

Student 1: “So, this should be Borrowdale volcanics along here and that’s sill up there (pointing at Zapp). Hopefully, fingers crossed.”

S2: “Beautiful specimen of Borrowdale volcanics coming up here.”

S1: “They’re just so craggy in comparison to the Skiddaw group found over here.”

Zapp was also used by the students as a tool for sweeping the landscape in order to explore what could be seen. As the students were assessed on their production of a rich media PowerPoint presentation, much of their videotaped use of Zapp was posed with a view to including the clip in a presentation later on. Several of the groups over both days stood on top of Catbells and recorded a 360^{o} panorama of the area. This appeared to give the students a method of orienting themselves by what they could see. Additionally, whilst performing these sweeps of the area, some groups found that they would discover features in the landscape which they were unaware of, usually because of lack of feature salience. For example, one group found a peat deposit on the Borrowdale volcanics which was quite small and because of the oblique angle at which it was situated they found it difficult to get a reliable lock on the deposit. But by using Zapp in this way, through group discussion they were able to hypothesize where it might be;

S1: “There’s some peat over there as well as some talus”

S2: “But due to some of the limitations of the device, we can no longer identify the peat”

As a part of their assessment, the students were asked to present on a slide what they thought of Zapp as a tool for learning in the field and were encouraged to include any suggestions they had to improve its usability. The student’s responses indicated that they liked the simple interface and the quick response of the application which was partly due to the data and calculations all being completed on the device without having to connect it to the internet. The students also used the ‘capture’ mode of Zapp as part of their data collection exercise, to identify features that contributed to their exploration of the landscape geology.

DESIGN CONSIDERATIONS AND IMPROVEMENTS TO ZAPP

Some changes were subsequently made to the user interface as a result of the feedback provided by the students, both as part of their assessment and from the video they had captured in the field. Although the learning objective was to understand the physical landscape, not to evaluate a technological intervention, the students were made aware that the system may not record an accurate position for a captured POI and that the DSM underpinning Zapp did not match the real world perfectly. From this, the main suggestion made from their assessment and infield feedback was that the user needed to know roughly the position of the point the device was calculating. This was particularly apparent when the POI they were trying to capture or query was at an oblique angle (figure 6) as error in the sensor input to the LOS algorithm could mean that the device captures or queries an unintended point. Also, due to the small screen size of the device and a lack of a zoom function, it was sometimes difficult to locate a potential POI on the screen.

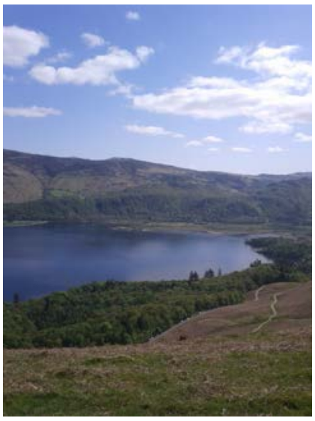

Figure 6. Photo captured from Zapp with an ambiguous POI

The simplest method of providing feedback to the user of what the device was pointing at in the landscape was to make the screen crosshair dynamic, such that the space in the centre of the crosshairs closed when the Zapp algorithm was detecting features of interest far away and opened out when the detected features were close. With this implemented, the user is now able to trace the crosshair across the landscape until the size of the central region of the crosshairs corresponds to the user's estimate of the distance of the POI, therefore increasing confidence to the user that the system has locked onto the correct point in the landscape.

Another suggestion which was implemented was to merge some features of the query and capture model such that the name of the POI being looked at would appear on the screen in capture mode and also be recorded in the captured points file as part of the logged data. This was suggested because of frustration when identifying a feature in the landscape in query mode and then having to re-find it in capture mode (without the text on the screen naming the current POI). Originally, this was not implemented to discourage students from "treasure hunting" in the landscape to attempt to find all of the media.

Future work will include more detailed testing of components of the system, such as the effect on error of changing the resolution of the DSM, and undertaking comparative studies of how Zapp enables learning in the field.

CONCLUSIONS

Students of geography, environmental sciences and history all have an interest in understanding the visible landscape, as do tourists at heritage sites and visitors to unfamiliar cities. For students, a central challenge is to enable learning in the field, so that they build an understanding of the landscape through a promotive cycle of visual scanning, identification of salient features, immediate confirmation of their visual interpretation, leading to their further scanning of the landscape for more subtle cues. Their learning can also be assisted by a 'landscape annotation' facility where they can record textual and audio notes linked to captured camera images of visible features that are then referenced to map coordinates. Later, they can access these notes when looking at the same feature from a different location and perspective, or they can study their collected pictures and notes located on a digital map to 'tell a story' about the rural or urban landscape. For tourists and visitors, there is an opportunity to provide a richer experience than current technologies that inform only about their current location or major landmarks, enabling visitors to scan their visual surroundings and ask, for example, "what is the name of that mountain peak?" or "what building can I see in the distance?". In this paper we have described a general purpose solution, based on a line of sight algorithm computed over a digital surface model stored on a smartphone. The algorithm and DSM can be adapted to open rural landscapes with coarse-grain mapping based on radar data, or more restricted urban environments with high resolution LiDAR mapping. Errors arising from inaccuracies in the smartphone compass and tilt sensors and granularity of the DSM will be reduced with next generation smartphones containing more accurate sensors and larger memory. A field trial of the Zapp system with Geography students has shown that the system is usable and useful and more useful than previous paper-based methods for gaining a full understanding of surrounding rock formations, to create a narrative explanation of the regional geology.

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Mobile learning and health-risk management of pulsed microwave technologies

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ABSTRACT

Many schools and educational institutions are using wireless Wi-Fi and Tablet technologies in their education. Recently WHO IARC classified radiofrequency (RF) radiation 'possibly carcinogenic to humans'. Currently guidance levels for electromagnetic fields (including RF) are based on thermal effects while effects have been reported on non-thermal levels. Possibly these biological, non-thermal effects are brain-related and affect cognition, memorizing and learning. We start by describing our measurement method used for Wi-Fi routers and laptop Wi-Fi antennas. Then a historical overview on thermal and non-thermal viewpoints is provided. The objective of this study is to quantify the actual RF radiation levels around Wi-Fi access points and laptop computers at educational facilities and to assess their compliance with the current thermal-only guidelines and also with precautionary, biological guidance levels. This paper ends to recommendations how to minimize radiation exposure in educational institutions.

Author Keywords
WLAN, Wi-Fi, health, learning, safety limit, radiofrequency, radiation, electromagnetic, risk management

INTRODUCTION

Mobile learning encompasses both learning supported by mobile technology and also learning in an era characterized by constant mobility of people and knowledge (Sharples *et al*., 2011). This constant mobility is achieved using a network of mobile phone base stations, wireless routers, computers, mobile phones and, recently, tablet devices. However, several scientists, governments and the European Parliament have emphasized precautionary principle and indicated health risks in pulsed microwave technologies, including for example Wi-Fi (Wireless Fidelity) and UMTS (Universal Mobile Telecommunications System). In 2009 the European Parliament pointed out that the exposure limits for general public are obsolete, since they haven't taken into account the developments in information and communication technologies (European Parliament, 2009) The World Health Organisation (WHO) and it's International Association of Research on Cancer (IARC) classified 2011 radiofrequency radiation (microwave radiation) as 'possibly carcinogenic to humans', based on epidemiological evidence on the connection of glioma (brain tumour) and mobile phone use (WHO, 2011). The biological, non-thermal effects of electromagnetic fields (EMF) are documented in the BioInitiative Report (BioInitiative, 2007) and in the ICEMS Monograph (ICEMS, 2010). At the same time authorities and standard setting bodies (like ICNIRP (International Commission of Non-Ionizing Radiation Protection) and IEEE (Institute of Electrical and Electronics Engineers) have not officially recognized such risks. The current European safety limits (the directive 1999/519/EC) are solely based on ICNIRP recommendations and the thermal effects of the Wi-Fi-frequency EMFs, with the research data preceding the year of 1999.

The focus of this paper is to measure pulsed radiofrequency radiation of Wi-Fi technology, view results in light of the recent research and provide recommendations to manage a possible risk. The measurements are conducted in the Wi-Fi-router environment to illustrate the gap between the new research data (BioInitiative Report) and the old data (EU directive). There are articles that cover technical measurements of the Wi-Fi technology in schools (Peyman *et al*. (2011). Similarly, there are already some research papers inspecting the health-related effects of Wi-Fi technology on humans (Papageorgiou *et al.*, 2011; Havas *et al.*, 2010; Maganioti *et al.*, 2010). However, based on our literature search on Pubmed (http://www.ncbi.nlm.nih.gov/pubmed/) and EMF-Portal (http://emf-portal.org) there are not articles covering health effects and risk-management of Wi-Fi technology in schools, except a commentary by Watson (2011). So, in that sense our approach might provide new contributions both for science and practice.

The need for the research of non-thermal effects of EMFs has been pointed out by the high-level European bodies. In 2009 the European Parliament issued a resolution (2008/2211(INI)) emphasizing the need to encompass Wi-Fi-devices into EU indoor air quality policies. The Council of Europe committee examined the evidence and issued a statement in 2011 saying that wireless technology is "potentially harmful to humans". The committee concluded amongst other recommendations that wireless networks (including Wi-Fi and mobile phone use) should be removed from schools and replaced with wired, Ethernet infrastructure. (Council of Europe, 2011)

Next we will describe the method and measurement protocol we are using for Wi-Fi access points and laptops. Thereafter we will illustrate the difference between thermal and non-thermal effects and related guidelines. Health studies related to pulsed microwave technologies (including Wi-Fi) are thereafter described. At the end of this paper we will present our measurement results and point out safer practices of Wi-Fi use.

METHOD AND MEASUREMENT PROTOCOL

Several Wi-Fi access points and laptops were measured. Measurements were taken at Tallinn University of Technology and at Tampere University. The measurement instruments were Gigahertz Solutions HF59B meters (Langenzenn, Germany). These high frequency (HF) analyzers measure pulsed radiofrequency radiation in scale 800MHz-2500MHz with a directional antenna.

The instruments were selected over the use of spectrum analyzers because of their wide bandwidth measurement method. The HF59B HF analyzers allow to catch the whole Wi-Fi power density level at once, unlike spectrum analyzers that scan the given frequency range one frequency step at a time. The spectrum analyzer approach might therefore miss some of the signal resulting an inadequate reading.

Five Wi-Fi-routers were measured at both locations. An average and a maximum reading was recorded on each router site. Data was recorded with two signal processing modes: 1) RMS (root mean square) and 2) peak. A directional antenna HF800V2500LPE174 (frequency response 800-3000MHz) was used to provide the signal analyzer mainly with the signal of a target router. Measurements were taken from a perspective of a sitting student's head, at distances of 0.2, 0.4, 0.8, 1.2, 2, 3 and 4 meters from the Wi-Fi router (access point). Routers were put into constant download state. At each distance the analyzer was rotated on horizontal plane around the router, the maximum reading was recorded.

Five laptop computers were measured in order to compare them to Wi-Fi-router's emissions. The laptop computers were put into constant upload state to maximize the use of Wi-Fi-antennas. Also the laptop screens were tilted to a typical an angle of 115 degrees. Otherwise the same measurement protocol was applied as with the routers and measurements are done from similar distances.

The measurement results were compared with existing European legislation - the EU directive 1999/519/EC on the limitation of exposure of the general public to electromagnetic fields. It should be noted that current legislation in regard to the EMFs in Wi-Fi-frequencies was formed on the basis of the thermal effects. Much concern has been raised by both the general public and scientific community, whether the existing legislation provides adequate protection from EMFs exposure. Therefore the comparison of the measurement results was also done to non-thermal, biological recommendation levels of the BioInitiative Report (BioInitiative, 2007). Next the background of current thermal guidelines and the BioInitiative Report's safety levels are addressed to point out possible shortcomings in providing general public with adequate EMF safety levels.

GUIDELINES AND BIOLOGICAL EFFECTS

Currently, the health debate around mobile phones, base stations and power lines is heated in many countries (NRK, 2008). The authors will provide here two views, both with supporter groups. Thereafter we will illustrate the measurement results and risk management practices.

The thermal effects view

After the Second World War, a German biophysicist, Professor Herman Schwan moved to the USA to work for the US defense department contracts in the area of electro-magnetic fields. Like infrared radiation, radio waves and microwaves produce heat when they're absorbed in sufficient quantity. Although not a biologist, Schwan assumed this heating was the only effect EMR would have on living tissue.

Schwan then estimated danger levels based on how much energy was needed to measurably heat metal balls and beakers of salt water, which he used to represent the size and presumed electrical characteristics of various animals. Appreciable heating occurred in these models only at levels of 100.000 microwatts / cm2 or above, so, incorporating a safety factor of ten, Schwan in 1953 proposed an exposure limit of 10.000 microwatts / cm2 for humans. By showing soon afterward that it took more than this intensity to cause burns in real animals, Solomon Michaelson seemed to have confirmed the safety of "nonthermal" dosages. No one tested for subtler effects, and the 10,000-microwatt level was uncritically accepted on an informal basis by industry and the military. In 1965 the Army and Air Force formally adopted the Schwan limit, and a year later the industry-sponsored American National Standards Institute recommended it as a guideline for worker safety. (Becker and Selden, 305, 1985)

Currently, the guidance levels for non-ionizing radiation in most of the Western countries are based on thermal effects. In other words, the current guidelines only restrict the intensity of the radiation to prevent tissue heating in excess of what the body's thermoregulatory mechanism can cope with (Hyland, 2000). The exposure is measured after maximum 6 minutes exposure, no cumulative, long-term effects are recognized. A specific organization is responsible for maintaining these guidelines, namely ICNIRP (International Committee on Non-Ionizing Radiation Protection) (ICNIRP, 1998). The ICNIRP guidance level for 2400 MHz (including Wi-Fi) is 10 W/m2 = 10.000 mW/m2. Manufacturers are allowed to produced Wi-Fi routers with maximum 100 milliWatts.

Reference levels for the Wi-Fi frequencies (2GHz and more) set by the EU directive 1999/519/EC are expressed as Equivalent plane wave power density Seq and are 10W/m2 (RMS value). If this limit is exceeded the directive assigns more detailed investigation to find out if basic restrictions are met, expressed as whole body average SAR 0,08 W/kg and localized SAR (head and trunk) 2 W/kg applying to the range of 10 MHz-10 GHz.

The WHO (World Health Organization) International EMF Project and ICNIRP see that there are no other mechanisms than heating that may affect health and therefore current safety limits are valid. Military uses microwaves for crowd control and non-lethal weapons (Becker and Selden, 1985). Bone fractures are healed using special frequencies and polarities of electro-magnetic fields (Becker, 1990). Interestingly, both these activities take place at non-thermal levels and can not be explained through heating. The independence and neutrality of ICNIRP, IEEE and WHO have been occasionally questioned (NRK, 2008; Slesin, 2005)

The non-thermal effects view

In 1952 the German physicist, Professor W. O. Schumann of the Technical University of Munich showed that there are electromagnetic standing waves in the atmosphere, within the cavity formed by the surface of the earth and the ionosphere. There is a resonating electromagnetic oscillation between earth and ionosphere in the 10 Hz region (Schumann resonance, 7.83 Hz). The intensity and spectrum of the Schumann Resonances vary markedly from day to night and with solar activity. At night both the brainwaves of a human being (measured by EEG) and the Schumann Resonances are dominated by very low frequencies (<5 Hz).

Human brains detect, use and react to natural low frequency signals, the Schumann Resonances. 7.83 Hz is the same frequency at which the hippocampus, the area of the brain responsible for short term memory, vibrates. (Cherry, 2002). In 1960's it was demonstrated how human cells communicate electronically and how voltage and polarity is changed when for example wound healing is taking place (Becker and Selden, 1985).

Already in 1970s Russian doctors diagnosed an illness called microwave syndrome, where chronic exposure to artificial electro-magnetic fields weaken human immune system (Gordon, 1979).

If the non-thermal effects would be recognized officially, the ICNIRP guidance levels could be dropped perhaps to the 1/10.000 part of their existing value. Several French cities adopted in summer 2009 the 1 mW/m2 limit recommended by the BioInitiative (2007). The reason for these low levels is based on evidence on several animal studies where chronic exposure in levels below 10 mW/m2 produces harmful effects (see an overview in Levitt and Lai (2010). According to Otto and von Mühlendahl (2007) the reproducibility of these non-thermal effects is usually poor, and no physiologic or pathogenic mechanism, so far, has been accepted by all organisations to explain these effects. Similarly, Lin (1997, 439) sees, that better understanding is needed of the mechanisms of interaction between RF/microwave radiation and biological systems, and of the significance of any observed effects.

POSSIBLE HEALTH EFFECTS OF PULSED SIGNAL IN WI-FI AND RF TECHNOLOGIES

Generally, pulsed microwave radiation is more harmful than continuous wave microwave radiation (Creighton *et al.*, 1987). Pulsed microwave radiation is produced by several, modern technologies like Wi-Fi routers, Wi-Fi laptops, mobile phones and mobile phone base stations.

There are 10 epidemiological studies of mobile phone base stations. In their review, Khurana *et al*. (2010) found out that 8 out of 10 epidemiological studies indicate increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances < 500 meters from base stations. Here we need to understand, that an epidemiological study of a mobile phone base station is different from Wi-Fi technologies. There are no epidemiological studies of Wi-Fi. The exposure level, RF power density levels close to a mobile phone base station may be smaller than next to a Wi-Fi router / antenna, but the exposure time is often longer. Elliott *et al.* (2010) inspected the connection of mobile phone base station and childhood cancers and found no correlation. In Elliott's research power density values were modelled, not measured.

The basic frequency and the carrier wave in the Wi-Fi technology is 2450 MHz. Additionally, the signal is pulsed, information is encoded in pulses. These pulses are between 50-500 Hz. There is also a beacon signal; both the router and the gadget send their device ID (identification) number at 10 Hz. This might be problematic, because this is very close to the strongest Schumann Resonance. The human DNA itself is very sensitive to RF-radiation and human DNA can act as a fractal antenna (Blank and Goodman 2011). The newest research related to Wi-Fi points out to effects on brain, heart and fertility. Papageorgiou *et al.* (2011) noticed that a Wi-Fi base station affected short-term memory of humans. Maganioti *et al.* (2011) noticed that radiation from a Wi-Fi-base station affected brain-functioning deleteriously in the alpha- and beta-band. This change was visible in women but not in men. Havas *et al.* (2010) noticed that a Wi-Fi-like pulsed microwave radiation affected heart-rate variability (HRV) in some research subjects. Avendano *et al.* (2011) showed that the use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation.

In summary, there is very little evidence on harmful effects of Wi-Fi. However, there is much research is done on pulsed 2450 MHz technologies before Wi-Fi era (see for example EMF-Portal, http://www.emf-portal.org). Findings point out to the direction that human behavior, functionality and memory is affected by the pulsed nature of radiation.

RESULTS AND DISCUSSION

At two universities a total of five Wi-Fi access points are measured. Similarly, a total of five laptop computers are also measured. An average and a maximum power density of all five access points and laptops are presented in table 1.

Distance (m) from	Access point		Laptop (Wi-Fi adapter)	
	Peak value	RMS value	Peak value	RMS value
0,2	22,6 / 48,0	1,16 / 1,50	12,2 / 17,2	1,65 / 3,40
0,4	11,1 / 21,0	0,74 / 1,01	4,69 / 7,20	0,78 / 2,26
0,8	4,56 / 5,60	0,27 / 0,41	2,12 / 3,40	0,56 / 1,31
1,2	2,04 / 2,80	0,13 / 0,22	1,04 / 1,88	0,35 / 0,82
2	0,59 / 1,50	0,05 / 0,08	0,45 / 0,93	0,16 / 0,49
3	0,46 / 0,57	0,04 / 0,07	0,29 / 0,62	0,11 / 0,30
4	0,29 / 0,48	0,03 / 0,07	0,19 / 0,32	0,07 / 0,19

Table 1. Power density of five Wi-Fi access points and five laptop PCs (average/maximum), measurement unit: mW/m²

We compare our measurements to the measurements of Peyman *et al.* (2010) in a class-room situation: The maximum power density values for the laptops and access points at 0.5 m were 22 mW/m² and 87 mW/m² respectively, decreasing to 4 mW/m² and 18 mW/m² at 1 m distance (Peyman *et al.*, 2010). By comparison Peyman *et al.*'s measurement results are higher about 3-4 times to ours. This is due to a specialized computer program used by Peyman *et al.* to maximize the Wi-Fi adapter radiation. We believe that using standard upload-download protocols produces more realistic results and basis for comparison.

Avendano *et al.* (2011) used a laptop computers with Wi-Fi and noticed decreases human sperm motility and increased sperm DNA fragmentation. Sperm were exposed to an average of around 6.8 mW/m² radiofrequency radiation for four hours. As seen from our measurement results, this level is easily outperformed by both Wi-Fi access points and laptop PCs. Avendano *et al.* measurements produce only one example of non-thermal effects of RF EMFs, well below official safety limits. Similarly, Atasoy *et al.* (2012) found out reduced fertility and structural changes on testes of rats when exposed chronically in close distance (25 cm) by Wi-Fi. However, animal-based research cannot be directly extrapolated to humans.

CONCLUSION AND RECOMMENDATIONS

To answer the question, do current safety limits protect public from all risks, the research of non-thermal effects suggests that all the factors related to possible Wi-Fi effects are not considered in current guidelines. If biological effects are taken into account for future safety limits, then the Wi-Fi technology is called for new innovative, less EMF-radiating solutions. Based on our results, we would recommend precautionary actions to reduce EMF exposure.

Recommendations for mobile learning environments at schools:

1. Keep the distance: place the devices away from student’s head and body.
2. Minimise the exposure time: no base stations (incl. Wi-Fi) in classrooms.
3. Avoid continuous mobile data transfer, prefer synchronised, off-line services.
4. Anytime, anyplace is not realistic. Turn Wi-Fi off when not needed.
5. Designated Wi-Fi Zones by modifying and shielding antennas. Adjust power levels. in a Wi-Fi-router.

The comparison of the measurement results was done to EU directive 1999/519/EC which were set in action to protect the general public from adverse health effects from EMFs. Only thermal effects of the EMFs in Wi-Fi frequencies were accounted for in the directive, leaving the door open for future research. Therefore the directive is based on a research available by the time of it’s approval by the European Parliament in 1999. Our measurements demonstrated that current Wi-Fi radiation in educational facilities is above established non-thermal health effects. This situation contradicts general EU occupational health and safety policy regarding EMFs that could be expressed as „better safe than sorry”. The Bioinitiative Report (2007) points out several new health effect mechanisms of the EMFs. In our opinion these new mechanisms should be researched further. Therefore the aim of this article was to point out the gap between “old data” and the “new data” that inevitably has raised the concern amongst the general public and scientific community likewise.

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An Analysis of the Educational Potential of Augmented Reality Games for Learning

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ABSTRACT

This paper presents a review of practical research papers on augmented reality games for learning. The study evaluates how these games may impact motivation (affective learning outcomes) and knowledge gain (cognitive learning outcomes). For the analysis, we use game design patterns for mobile games and Bloom's taxonomy of educational objectives. Our study results substantiate the generally assumed motivational potential of augmented reality games. Also, they indicate that augmented reality games may have the potential to bring about cognitive learning outcomes.

Author Keywords

augmented reality games, mobile learning, mobile games, game design patterns, learning outcomes

INTRODUCTION

Taken into consideration the younger generation's habits of using media, e.g. their affinity for digital games and mobile handheld technologies, traditional education has long lived a life of its own. For the last several years however, the interest of teachers and educational scientists in innovative technology for learning and teaching has grown. They have recognised the educational potential these technologies provide, i.e. setting up challenging and engaging scenarios that enable new forms of teaching and learning (Carstens and Beck, 2010; Johnson et al., 2011; Klopfer et al., 2011; Squire, 2010). Game studies and mobile technologies have thus become a fast-growing field of research. Most of the projects still centre on technological aspects though. In order to determine the factors, mechanisms and design elements that make the use of novel learning scenarios successful and transferrable, it is necessary to explore how these technologies can be used for teaching and learning (Dunleavy et al., 2009; Huizenga et al., 2009; Klopfer, 2008).

The objective of this paper is therefore to scrutinize the learning effects of augmented reality (AR) games for learning and to understand the specific mechanisms that have led to these effects. The results could provide valuable insight into the working mechanisms of AR learning games that may positively influence future design decisions.

AUGMENTED REALITY

Augmented Reality and game based learning is commonly expected to gain widespread usage (Johnson et al., 2011) and for the last couple of years, AR games have increasingly been subject to practical studies (Botella et al., 2011; Fotouhi-Ghazvini et al., 2009; Specht et al., 2011; Wetzel et al., 2008). AR can be defined as 'a system that enhances a person's primary senses (vision, aural, and tactile) with virtual or naturally invisible information made visible by digital means' (Specht et al., 2011, p. 117). It has been considered significant tool for education (Johnson et al., 2011) with the potential to shape 'participants' learning styles, strengths, and preferences in new ways beyond what using sophisticated computers and telecommunications has generated' (Dunleavy et al., 2009, p.8). Integrating AR technology into mobile games can give educators powerful new ways to show relationships and connections (Yuen et al., 2011) and 'can increase learning by immersion as well as provide a richer learning experience' (Liu and Chu, 2010, p. 633).

AR games extend wireless games towards being more bound up with real locations and activities. They take advantage of the real-world context (Fotouhi-Ghazvini et al., 2009) and provide the realization of the probability of immersive learning (Liu and Chu, 2010). 'Real world games that are augmented with computing functionality and supported by the combination of real and virtual game elements create new and exciting gaming experiences for highly motivated learning' (Winkler et al., 2008).

The game concept is being used with a wide range of technology. It spans mobile handheld-based systems running on a PDA or a smart phone as well as AR systems comprising a backpacked laptop and a head-mounted display to augment reality (Wetzel et al., 2008; Yuen et al., 2011). By now, supplementary core technologies, such as Global Positioning System (GPS), portable displays, Radio Frequency Identification (RFID) reader or augmented devices such as the smart phone's Bluetooth, Infrared or camera, are an integral part of almost any up-to-date mobile device. Thus, and because of the 'increasing pervasiveness of smart phones, AR is set to become a ubiquitous commodity for leisure and mobile learning' (Specht et al., 2011, p. 117).

DESIGN PATTERNS FOR MOBILE GAMES

Traditionally, games are categorized according to game genres, i.e. adventure games, role-playing games, strategy games or simulations (cf. Prensky, 2007). In the context of current game research, this categorization has proved to be of little use though (cf. Davidsson et al., 2004; Gros, 2007). Especially in the context of educational games the categorisation according to genres is not stable and rather difficult to apply. Efforts to find a more adequate structure and language to better understand the complex issue have resulted in the development and application of game design patterns (cf. Björk and Holopainen, 2004; Cook, 2010; Kelle et al., 2011; Kiili and Ketamo, 2007).

This paper is thus based on the pattern approach. It applies the Game Design Patterns for Mobile Games by Davidsson et al. (2004) to establish a framework for the analysis of augmented reality learning games. The approach by Davidsson is advancement to the work of Björk and Holopainen (2004), who established an initial set of more than 200 game design patterns for computer games. Each pattern is identified by a core definition, a general definition, example(s), descriptions of how to use the pattern (by listing related patterns or patterns that can be linked to it), the description of its consequences, relations with regard to instantiation (patterns causing each other's presence) and modulation (patterns influencing each other), as well as references.

The pattern *Physical Navigation,* for example, 'forces players of a mobile game to move or turn around in the physical world in order to successfully play the game' (Davidsson et al., 2004, p. 18). The AR game *Explore* (Costabile et al., 2008) for instance uses this pattern. It requires groups of students to walk around ruins trying to identify the place the mission refers to. Also, the AR game *Alien Contact!* (Dunleavy et al., 2009) uses this pattern. Players have to move around their school playground or sports field to find digital objects and to complete tasks. The pattern *Physical Navigation* is instantiated by (caused by the use of), e.g., the pattern *Player-Player Proximity, Player-Artefact Proximity, Player-Location Proximity* and *Artefact-Artefact Proximity.* The pattern *Player-Location Proximity* in turn is defined by the distance between the player and a certain physical location, which can affect game play and trigger an event. *Alien Contact!* makes use of this pattern, too. 'When students come within approximately 30 feet of these digital artefacts, the AR and GPS software triggers video, audio, and text files, which provide narrative, navigation and collaboration cues as well as academic challenges' (Dunleavy et al., 2009, p. 10).

LEARNING BY PLAYING

We classified the effects, which we extricated from the review of practical papers according to learning outcomes. A learning outcome is the specification of what the successful learner is expected to be able to do at the end of the module/course unit or qualification (Adam, 2004). One of the main ideas of learning outcome orientation is to prepare students for the requirements of professional life (Vander Ark, 2002). Rather than defining the resources to be used during the learning process, outcome-oriented learning scenarios focus on the results of the educational process, e.g. the skills and content students are able to demonstrate.

To depict the various learning outcomes, we applied Bloom's taxonomy (1956), which sorts learning outcomes into three domains: *affective domain* (motivational learning outcomes), *cognitive domain* (knowledge learning outcomes) and *psychomotor domain (*manual/physical learning outcomes). According to Bloom, the affective domain encompasses attitudes and motivation. The cognitive domain deals with the recall or recognition of knowledge and the development of intellectual abilities and skills. The psychomotor domain encompasses manual or physical skills or the performance of actions. For the review we focused on motivational and knowledge learning outcomes. Learning outcomes that relate to manual or physical learning outcomes, e.g. exergames (Lucht et al., 2010; Yang and Foley, 2011) or console games we did not consider, as they have a different didactic approach.

For the cognitive domain, Bloom distinguishes six successive levels that can be fostered – Knowledge (e.g. observation and recall of information, knowledge of dates, events and places), Comprehension (understanding information, grasping meanings or ordering, grouping, inferring causes), Application (using learned material in new situations, putting ideas and concepts to work in solving problems), Analysis (breaking down information into its components, understanding organisational structure), Synthesis (putting parts together) and Evaluation (judging the value of material for a given purpose). This analysis aims at identifying which level of knowledge AR learning games may enable.

LITERATURE REVIEW

Our study evaluates well-documented AR games designed for teaching and learning (educational games or serious games). Patterns and learning outcome definitions provide the framework for our analysis. Due to the educational focus of our analysis, we excluded any study focusing at technology aspects, such as the study on 'The Eduventure' by Ferdinand et al. (2005) or the 'Museum Scrabble' by Yiannoutsou et al. (2009). We also excluded papers that state evaluation results on an unspecific level with regard to patterns, e.g. 'the use of mobile learning games contributes to the development of collaboration skills' (Sánchez and Olivares, 2011; p. 1950). The terms we used in the search included the following keywords: (ubiquitous, mixed reality, augmented reality) learning game, mobile educational game, mobile serious game, mobile game-based learning.

Results

In a first step, we scrutinized what augmented reality games impact motivation (affective learning outcomes) and what games impact knowledge gain (cognitive learning outcomes). We then went into detail, focusing on the patterns that were used in these games and analysed how they impact learning outcomes.

Affective Learning Outcomes

In the course of our review, we identified several patterns that positively influence motivation both in terms of fun as well as getting engaged with a learning environment or a certain topic, which for instance helps the learned material to penetrate into the long-term memory (Kittl and Petrovic, 2008). Table 1 lists these patterns, describes them and presents the effects. The pattern descriptions are taken from the list of patterns by Davidsson et al. (2004).

Pattern	Pattern Description	Affective Learning Outcome
Collaborative Actions	Two or more players being at the same location at the same time or attacking a target simultaneously.	Students are engaged in the game (Costabile et al., 2008; Dunleavy et al., 2009; Liu and Chu, 2010; Rosenbaum et al., 2006).
Cooperation	Players are forced to work together in order to progress in the game.	Students exchange and discuss game progress (Klopfer and Squire, 2008).
		Participants are driven by a good team spirit (Costabile et al., 2008).
Social Interaction	Players have the possibility to meet face to face.	Students are engaged in discussion (Klopfer and Squire, 2008).
Augmented Reality (AR)	Players' perception of the game world is created by augmenting their perception of the real world.	Students feel 'personally embodied' in the game. Their actions in the game are intrinsically motivated (Rosenbaum et al., 2006).
		Learners are attentive (Wijers et al., 2010).
		Students are mentally ready for learning (Schwabe and Göth, 2005).
Physical Navigation	Players have to move or turn around in the physical world in order to successfully play the game.	Students are highly motivated (Dunleavy et al., 2009).
		Participants are interested and moved (Schwabe and Göth, 2005).
		Students's are exited (Facer et al., 2004).
Agents	Entities controlled by the game system, e.g. to support narrative structure.	Students are motivated to deal with the learning material (Liu and Chu, 2010).

Table 1. Motivational effects of mobile game design patterns used within AR learning games.

The pattern *Roleplaying* is not part of the revised list by Davidsson et al. (2004). It is part of the original list of *Game Design Patterns* provided by Björk and Holopainen (2004). However, the pattern seems to be highly relevant for the design of AR learning games. We therefore included it in the study. Table 2 comprises the results.

Pattern	Pattern Description	Affective Learning Outcome
Roleplaying	Players have characters with at least somewhat fleshed out personalities. The play is centred on making decisions on how these characters would take actions in staged imaginary situations.	Learners are involved in the game (Facer et al., 2004).
		Students feel highly engaged and identify with their roles in the game (Facer et al., 2004, Costabile et al., 2008).
		Students merge with the game (Rosenbaum et al., 2006).
		Learners are tightly associated with their tasks in the game (Rosenbaum et al., 2006, Wijers et al., 2010).
		Students take on an identity and are eager to work together (Dunleavy et al., 2009)

Table 2. Motivational effects of the pattern Roleplaying used within AR learning games.

Mobile game-based learning approaches seem to be a viable way to go about the ‘disengaged learner’ for they provide the potential to engage learners with the material to be learned. The ‘MobileGame’ (Schwabe and Göth, 2005) for example helps students to get accustomed to a new university campus. By virtually attaching tasks to objects, it electronically supplements the traditional orientation rally with handheld devices. Based on a map, the rally leads students through a parcours with several tasks to carry out at certain spots. Its main concept is that of teams competing against each other while solving different tasks. Thus, the ‘MobileGame’ makes use of patterns such as Augmented Reality, Collaborative Actions, Common Experiences, Communication Channels, Cooperation, Extra-Game Information, Physical Navigation, Player-Location Proximity, Predefined Goals, Race, Team Play or Score.

The evaluation of the ‘MobileGame’ by Schwabe and Göth (2005) indicates that both, the pattern *Augmented Reality* and the pattern *Physical Navigation* positively influence students’ engagement and attitude towards learning. Working on the various tasks at significant places provides the base for learners to ‘immerse into a mixed reality that augments both physical and social space’ (p. 204). According to the study results, AR moves students into a state where they are ‘mentally ready for learning, where they are in the right environment for learning and where they also already experience some socially oriented learning” (p. 215). The game element of ‘map-navigation’, which provides the base for the orientation game, keeps participants interested and moved.

Also, the evaluation of the ‘Virus Game’ (Outbreak@The Institute) by Rosenbaum, Klopfer and Perry (2006), reports on motivational learning outcomes. It uses patterns such as *Augmented Reality, Collaborative Actions, Common Experiences, Imperfect Information, Physical Navigation, Player-Location Proximity, Score, Team Play and Roleplaying.* The positive learning outcomes can be correlated with the patterns *Augmented Reality* and *Collaborative Actions*. The pattern *Augmented Reality* is defined as player’s perception of the game world that is created by augmenting the player’s perception of the real world (Davidsson 2004). Rosenbaum et al. state that by augmenting reality, students ‘felt personally embodied in the game’ (p. 38). When the bar graph on their PDA screen that represents their health started to drop for example, they spoke and acted as though they were actually sick (p. 38). ‘When they were not sick, they responded to sick players with fear and alarm attempting to physically move away from them’ (p. 38).

The pattern *Collaborative Actions* is defined as goals in mobile multiplayer games that can only be reached through a *Collaborative Action* (Davidsson 2004). Two or more of the players execute this pattern. It includes but is not limited to the action of simply being at the same location at the same time or attacking a target simultaneously. In the ‘Virus Game’, the pattern *Collaborative Actions* is implemented by providing different roles with distinct abilities. ‘Each of the roles is dependent on the others both for information and for action. This fosters collaboration through jig sawing’ (Rosenbaum, Klopfer and Perry, 2006; p.40). The study by Rosenbaum, Klopfer and Perry indicates that *Collaborative Actions* can bring about a change in students’ attitude by providing insight into the working mechanisms of interpersonal communication. In the course of the ‘Virus Game’, students depend on each other for information and for action to reach their goal. The ‘jig sawing of complementary information’ (p. 35) brought about ‘an understanding of the interdependence of the roles’ (p. 43). Students ‘grasped the resulting importance of communication and collaboration for success in the game’ (p. 40).

Also, the learning game ‘MobileMath’ provides for motivation and aims at exploiting this motivation for meaningful learning. ‘MobileMath’ uses patterns such as *Augmented Reality, Collaborative Actions, Common Experiences, Continuous Goals, Cooperation, Configurable Gameplay Area, Hybrid Space, Memorabilia, Multiplayer Games, Physical Navigation, Player Location Proximity, Race, Score, Social Interaction, Team Play, Competition*. The evaluation of ‘MobileMath’ by Wijers, Jonker and Drijvers (2010) describes *Competition* as an essential factor in enhancing students’ engagement with the game. *Competition* is implemented in terms of teams playing against each other. In the course of the game, ‘teams can see themselves and the others as colored dots moving in real time in the playing field on the underlying map. The goal is for a team to gain points by covering as much area as possible with virtually constructed parallelograms’ (p. 792). It showed that especially the ‘option of destroying shapes of others brings in an extra competitive element. This feature proved to be very engaging’ (p. 798).

As for the pattern *Augmented Reality,* the authors state that augmenting the real world increased students’ attention and motivation to get engaged with a certain topic. By creating geometrical shapes on a previously defined playing field (map), students create an imaginary layer on top of the physical reality. Additionally, ‘interaction between the teams mainly took place in the virtual reality: they spotted each other more easily on screen than in the physical reality’ (Wijers, Jonker and Drijvers, 2010; p.797).

Cognitive Learning Outcomes

From the study results it seems that the assumed positive effects of MLGs on the student’s knowledge gain are hard to substantiate. The review reveals that only few studies include quantitative data on game usage. Papers discuss the educational value of games but provide little empiric evidence that this approach leads to better learning outcomes. However, some of the evaluations show positive interrelations between using a mobile learning game and knowledge gains. In the following, we exemplary depict games that influence cognitive learning outcomes. We describe patterns they use and illustrate how they impact cognitive learning outcomes. Table 3 presents the patterns within augmented reality learning games that have cognitive effects and relates them to one of the levels distinguished by Bloom. The findings, we formulated in line with the verbs Bloom considered as suitable for describing the several levels in written objectives.

Most of the cognitive effects we subsumed to the level of 'Comprehension', which Bloom defined as a level where students are able to understand information or to grasp meanings, e.g. students can explain and rewrite the knowledge learned (Liu and Chu, 2010). The study carried out by Liu and Chu (2010) investigates the potential of the learning game HELLO (Handheld English Language Learning Organization), which uses the Internet, ubiquitous computing and AR technology to increase learning outcomes. The game implements patterns such as *Player-Location Proximity, Augmented Reality, Extra-Game Information,* or *Collaborative Actions.* To measure the cognitive effects, Liu and Chu evaluated students' English listening and speaking skills. The results indicate that HELLO improves learning. This is because the MLG provides many interesting learning materials for example (pattern: *Extra-Game Information*). The pattern *Extra-Game Information* is realized as follows: each student has access to u-tools for English learning. The u-tools include several tools, which can be used to access self-study English songs, listening materials, and conversational materials (Liu and Chu 2010, p.635). Also, with HELLO the learning improved because students collaborated in their tasks in real conditions for example (pattern: *Collaborative Actions*). During the game, the collaborative learning activity was a story relay race. In the beginning, the students could listen to several sample stories, after which they were asked to edit a story collaboratively (Liu and Chu, 2010).

Pattern	**Pattern Description**	**Cognitive Learning Outcome**
Collaborative Actions	Two or more players being at the same location at the same time or attacking a target simultaneously.	Students can explain and rewrite the knowledge learned (Liu and Chu, 2010).
Social Interaction	Players have the possibility to meet face to face.	Students are able to scientifically argument (Klopfer and Squire, 2008).
		Students can rewrite the knowledge learned (Liu and Chu, 2010).
Augmented Reality (AR)	Players' perception of the game world is created by augmenting their perception of the real world.	Students notice and discuss geometrical aspects of the world (Wijers et al., 2010).
		Students can describe and illustrate a disease model (Rosenbaum et al., 2006).
		Students reflect on the process of learning (Costabile et al., 2008).
Extra-Game Information	Information is provided within the game that concerns subjects outside the game world.	Students can rewrite the knowledge learned (Liu and Chu, 2010).
Roleplaying	Players have characters. The play is centered on making decisions on how these characters would take actions.	Students can give examples for the importance of communication and collaboration (Rosenbaum et al., 2006).

Table 3. Cognitive effects of patterns used within AR learning games.

The study results by Costabile et al. (2008) on Explore! – Gaius' Day in Egnathia also argue that augmenting the players' reality positively influenced their learning outcome. The debriefing phase of Explore! provides 3D reconstructions and interactive maps, enabling students to reflect on their learning. They allow students to 'see their movements in the site and their overall performance, and so better understand the errors they made' (p. 152).

Wijers et al. (2010) recognized that the pattern *Hybrid Space* changed students' perception of the city. In 'MobileMath' the players immerse in a mixed reality game environment, in which they create virtual elements (i.e. mathematical shapes) by interacting with the real world. The game changed their perception of reality. Mathematical details became a natural part of it. When playing, the students 'noticed and discussed geometrical aspects of the world such as if streets make right angles or not and whether they are running parallel' (p. 798).

DISCUSSION

To truly understand the implications of the many patterns that exist and to make effective use of their corresponding individual shapes, we must explore isolated patterns or groups of related patterns. The studies we reviewed did not explicitly focus on this but on a set of diverse patterns embedded in the games. Therefore, the impact of one particular pattern on knowledge gain is difficult to determine.

Also, the effects occurred with a given condition of the patterns, e.g. time, level, etc. We assume that varying the conditions of the diverse patterns (game balancing) has an influence on the effect too. Also, the studies we reviewed varied with regard to study design and terminology. The same applies to the statistical base (dependent/independent variables) and the research methods (quantitative/qualitative) the studies were based on, as they addressed various research interests. Still, some verifiable effects are in existence.

In order to reduce such complexities in the pattern approach, further research on the correlations between patterns and learning outcomes has to focus on a limited number of the patterns in existence (cf. Björk and Holopainen, 2004; Davidsson et al., 2004). The study settings have to comprise (a) an experimental variation of patterns, i.e. game settings that enable/disable individual patterns and (b) an in-depth variation of patterns, i.e. game settings that allow different instances for the same pattern. This way, measurable and feasible results can be obtained that are suitable as a base for design guidelines which define (a) patterns that support the achievement of a desired learning outcome and (b) ways of applying the patterns. Future research needs to verify the effectiveness of mobile learning games and to corroborate their educational value in order to motivate teachers to use such tools for teaching. Otherwise, the educational system may run the risk of disengaging future learners (Klopfer et al., 2011).

CONCLUSION

Studies on AR learning games frequently stress the manifold teaching and learning challenges they provide. Especially their power to create learning environments that foster teamwork, collaboration, social interaction and cooperation is frequently emphasised, e.g. the provision for 'jigsaw pedagogy' (Dunleavy et al., 2009, Rosenbaum et al., 2006), which is documented a most engaging and interesting feature. It is characterized by providing different information to different roles in the game. Just as in regular schooling, forms of collaborative participation support learners' engagement and motivation in the game and may eventually help to process and memorize the knowledge provided. However, few studies empirically prove the assumed cognitive learning outcomes (Costabile et al., 2008; Huizenga et al., 2009; Klopfer and Squire, 2008; Liu and Chu, 2010). Henceforth, it will be necessary to conduct more quantitative and qualitative research in order to define how AR learning games and their individual patterns or groups of related patterns support or hinder teaching and learning.

FUTURE WORK

Identifying the specific elements that students and teachers found most motivating is critical for developing progressively more effective AR curricula (Dunleavy et al., 2011). There is a need for a more detailed analysis of the effect of MLGs, on design patterns that occur in AR learning games and the relation between the patterns used and their effect on the learners.

The study results show a small, though positive correlation between diverse patterns and cognitive learning outcomes: *To what degree does a particular pattern, e.g. Augmented Reality, increase the learner's knowledge gain?* Also, from the study results, positive correlation between patterns and affective learning outcomes emerged: *How does a single pattern, e.g. the provision for Alternate Reality in the game, influence the learners' motivation to actually deal with a particular subject or a given learning content?*

A comprehensive study is yet to follow which examines the research questions stated and seeks to understand which specific patterns have the greatest impact on a stated learning outcome. The results of this study will be published in due course.

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The Use of Quick Response Codes in the Classroom

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ABSTRACT
The purpose of this article is to explore and analyse teaching methods and processes that incorporate Quick Response (QR) codes and mobile devices into the classroom. Quick Response codes are two dimensional barcodes that are used to encode and decode information. QR codes can contain information such as text, URL links, automatic SMS messages, or just about any other information that can be embedded in a two-dimensional barcode. This encoded data can be decoded by scanning the barcode with a mobile device that is equipped with a camera and QR reader software. Although QR codes are very versatile and have been around for over fifteen years, their use in education is still in its infancy. This paper introduces the available implementations of QR codes in education. These implementations were developed with teachers to correspond to their needs and wishes. The students were very enthusiastic and motivated but the teachers' attitude was more sceptical. The main feedback from the teachers was that the planning of QR activities is an arduous task when one is not familiar with QR codes or the ways to utilize them. In our study we found that QR codes can support learning in different contexts. We also found that QR codes can support both independent and collaborative learning and that QR codes can motivate and engage learners.

Author Keywords
Quick Response (QR) Codes, Mobile Learning, Independent Learning, Collaborative Learning

INTRODUCTION
Mobile technologies have changed our societies in many respects. They have affected the way people interact with each other and how they communicate, work and spend their leisure time. Mobile devices, systems and technologies are now universally owned, accepted and used. As a consequence, also the meaning and significance of learning are changing. (Traxler, 2009)

Mobile technologies can respond to these changes in learning. Researchers and educators have recognized the potential of mobile technologies as learning tools, and mobile technology has promoted a new learning style, mobile learning. By mobile learning we mean learning that happens when the learner is not in a fixed, predetermined location and/or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies (O´Malley et al., 2004). At best, mobile technologies facilitate learning outside of the classroom, and learning materials are no longer limited to textbooks (Shih, Chu, Hwang & Kinshuk, 2011).

The study of QR codes in education can be placed in the context of mobile learning. Research has been conducted on mobile learning all over the world but only a few studies have addressed the use of QR codes in education (Law & So, 2010). The aim of this study is to explore and analyse teaching methods and processes that incorporate QR codes and mobile devices into the classroom. This article is organized as follows: first the theoretical background is discussed, after which we will move on to provide examples of applying QR codes in an educational setting. There is a variety of ways to use QR codes in an educational context, which, based on our literature review, can be divided into five main categories. We introduce these five categories as well as our QR experiments and the responses received from the students and the teachers. We carried out five different QR experiments in schools in Central Finland in May 2012. We will conclude the paper with reflective remarks.

THEORETICAL BACKGROUND
Learning is changing and the educators, employers, parents and the public have begun to emphasize the need for lifelong learning and 21st century skills. Technologies can respond effectively to these changes in learning and technologies have made many new educational forms possible. It has been shown that innovative teaching practices can support students in developing the skills they will need in future life and work (Norrena, Kankaanranta & Nieminen, 2011). Based on the literature review (Rikala, 2012), innovative teaching practices (e.g. student-centred pedagogy, extending learning beyond the classroom) can be realized through different mobile learning solutions. We found that learning with mobile technologies can be very personalized, situated and authentic and that at best mobile technology can bridge formal and informal learning, make learning more student-centered and encourage creativity and innovation.

Based on the literature review (Rikala, 2012), we can suggest that the core characteristics of mobile learning are personalisation, authenticity, and collaboration. The authenticity feature can promote learning scenarios such as contextualized, participatory and situated learning (Kearney, Schuck, Burden & Aubusson, 2012). Situated learning activities promote learning within an authentic context and culture. Mobile devices are very well suited for context-aware applications because mobile devices are available in different contexts and are able to extend the learning environment into authentic contexts. Mobile devices can provide additional information based, for example, on the location and make available activities that are relevant to the environment. (Naismith, Lonsdale, Vavoula & Sharples, 2004)

The study of Quick Response (QR) codes in education can be placed in the context of mobile learning. QR codes are two-dimensional barcodes consisting of black modules on a white background. These square pattern codes can contain information such as text, URL links, or other data that can direct users to sources for more information about a particular place of subject. (Lee, Lee & Kwon, 2011) Users with a camera phone equipped with a QR code reader application and a data connection can scan QR codes to display text, open a web page, send automatic SMS messages, or similar. There are several different mobile apps that can be used to read and decode QR codes.

In our literature review we found that QR codes can support learning when students move in the field (e.g. in trail and field activities). With the QR codes embedded in the environment, students can obtain contextual or location-aware information (Osawa et al., 2007). QR codes also allow the implementation of innovative systems based on the paradigm of just-in-time learning and collaborative learning (De Pietro & Frontera, 2012). With QR codes it is also possible to connect digital resources to printed text. This implies the potential to enrich paper-based learning materials. These enriched learning materials can serve and motivate students with different learning needs. (Chen, Teng & Lee, 2010)

In our literature review we found that on the whole QR codes can expand the learning experience and provide authentic tasks that take place in real-world settings. Learning can happen outside of the classroom and learning materials are no longer limited to textbooks. Thus overall learning with QR codes can be very personalized, situated and authentic.

QR CODES IN AN EDUCATIONAL CONTEXT

When considering QR codes in an educational context, it is important to see QR technology as an enabler. The focus should be more on the learners and pedagogy than on QR technology, as mobile technologies do not guarantee enhanced learning by themselves. The potential for mobile learning is dependent on the provision and development of pedagogically meaningful opportunities and environments that enhance learning. The intention should be to promote more learner-centered learning, not to bind teaching and learning to mobile devices. (Zhang et al., 2010)

There is a variety of ways to use QR codes in an educational context. Our literature review indicated that they can be divided into five main categories as follows:

- Trail activities or treasure hunts (Law & So, 2010)
- Outdoor or field activities (Lee et al., 2011; Law & So, 2010)
- Paper-based tasks (Law & So, 2010)
- Learner generated content (Mikulski, 2011)
- Working instruction (Walker, 2010)

In trail activities or treasure hunts, pupils or students explore their communities and solve problems that relate to what they find. This kind of activity can be organized in the form of collaboration or competition between the students but may also be used to support individual study. Law and So (2010) carried out a math trail activity in which students explored their communities and created one or more math problems that related to what they found. At each location, the students answered a question by scanning a code and writing down their answer. Law and So (2010) discovered that the students found the activity interesting and they were very curious about the new approaches that deviated from their routine exercises.

In outdoor or field activities, pupils or students can explore life science subjects such as species of wild fauna or flora. A QR code can, for example, give hints when identifying the species or provide additional information about them. The code may, for example, include a link to resources that direct the learners to information about the living conditions of the species. Lee et al. (2011) incorporated QR codes and smart phones into field trips for biology classes. Students explored and identified species at the field study site using a QR code sheet and shared their results with their classmates via a social network system, presentations, and discussions. Lee et al. (2011) found that, with QR codes, teachers can create customized guidebooks for individual field studies and students learn more effectively because the code only contains information that is relevant to the matter at hand. They also noticed that QR code activities can integrate digital learning materials with field trips in a motivating way.

In paper-based tasks, QR codes can contain links to multimedia resources such as audio materials or video clips in the case of listening exercises. In paper-based tasks, QR codes can also guide learners through the self-assessment process. For example, a QR code on the worksheet can direct the learner to a web page showing the right answers and the learners can check up on how much they have learned. Law and So (2010) used QR codes to demonstrate how QR codes can be used as part of a listening exercise. They noticed that QR codes provided a very efficient and flexible way for the students to obtain the resources ubiquitously. Law and So (2010) also used QR codes to guide the learners through the self-assessment process. The QR code printed on the worksheet directly linked to a web page with the right answers. Students' feedback indicated that it was more convenient and quick to use mobile devices and QR codes for individual exercises.

In learner-generated content, learners can produce reports or other materials online and share their work with QR codes. For example, students can record book reviews and attach the QR code to the inside cover of the book or they can write children's books and record their reading and then add QR codes linking to the audio to create an interactive reading experience. At best, this approach can support learner-centred learning.

In working instruction, the teacher can give directions and information to students on how to complete their assignments. For example in art workshops, QR codes can be placed on pieces of equipment such as different kinds of brushes, or in an engineering workshop on different electronic equipment to guide students in their use. At best, this approach can support independent learning.

These above-mentioned activities and tasks can, of course, be mixed and combined. For example, there could be an outdoor treasure hunt and a paper-based task combined with a trail activity. In our experiments, we mixed and combined a variety of different types of activities. In the next chapter, we introduce our QR experiments and the responses we received from the students.

RESEARCH DESIGN

We carried out five different QR experiments in schools in Central Finland in May 2012 (Table 1.). The aim of the study was to explore and analyse teaching methods and processes that incorporate QR codes and mobile devices into the classroom. Our research methods included surveys and observations. We had a different survey for the primary school students and the secondary and upper secondary school students. The survey scales differed: the questions and the scales were easier for the primary school students.

School	Duration	Equipment	Grade level	Sample
Primary school 1	1 hour and 40 minutes 1 hour and 40 minutes	Loaned out by the researchers	3rd-4th grade students (aged 9-10 years) 5th grade students (aged 10-11 years)	17 students 25 students
Primary school 2	2 hours and 30 minutes	Loaned out by the researchers, a few students used their personal devices	5th-6th grade students (aged 10-12 years)	15 students
Secondary school	2 x 45 minutes	Loaned out by the researchers	7th grade students (aged 13-14 years)	15 students
Upper secondary school	30 minutes	Personal devices belonging to the school	Second year students (aged 17-18 years)	4 students
			Total	76 students

Table 1. The experiment design.

In primary school 1, we arranged a treasure hunt for 3rd-4th grade students and for the 5th grade students. The overall objective of the lesson was to enhance the students' information retrieval skills and to bring some change to a traditional school day. The QR activity was planned out so that there was collaboration and also some competition among the students. Different coloured QR codes guided the students through the route. Each coloured QR code gave a hint of where to find the next code. Near each coloured QR code, there was a black QR code that contained the actual task. This task was an information retrieval task, which the students completed after the treasure hunt on a computer. The team that racked up most right answers was rewarded with applause. The students were very enthusiastic even though there were some technical problems: the mobile phone's camera and QR code reader did not always work as expected.

In primary school 2, we arranged a paper-based trail activity that guided learners through the self-assessment process. The activity also included collaboration between the students and learner-generated content. The overall objective of the lesson was to teach topics relating to physics. The primary school 2 teacher was eager to test new teaching methods and volunteered to design and test a QR activity. In the QR activity the students completed a group work and research task on topics relating to physics such as renewable and non-renewable energy sources. Each group prepared a web page about their main findings, a worksheet with questions, and an embedded QR code, which provided a link to the group's web page. The worksheets were distributed around the school and the students went through them trying to answer the questions. If the students did not know the right answer, they could scan the QR code and try to find the answer on the web page. The students were very enthusiastic even though there were some technical problems with signing on to the web page with mobile phones.

In the secondary school, we arranged a story trail activity for the 7^{th} grade students. The main idea behind the QR activity was that the students would plan two stories: one in the classroom by using traditional methods and the other by going round the QR code trail in the woods. Actually the contents of the help questions were the same in the woods and in the classroom. The aim was to study if the students would get more inspiration in the woods than in the classroom. In the QR code trail, it seemed that planning the story remained in a secondary role. Some students played music on their phones; some discussed completely different matters, etc. It seemed that the code reading part was interesting but the activity itself was not. There were also some technical problems: the phone's camera and QR code reader did not always work as expected, which caused disorder.

In the upper secondary school, we arranged a QR activity that guided the students at the gym (Figure 1).

Figure 1. Preparing and implementing a QR code activity at the upper secondary school.

This upper secondary school was looking for new ways for distance education and independent learning and was enthusiastic to test the potential of QR codes. The physical education teacher planned and prepared with the help of a media assistant videos that showed how to do gym movements correctly. These videos were transferred to YouTube and this YouTube link was embedded in a QR code. Four students were chosen to test these QR codes. The students scanned the QR codes with their mobile device's QR code reader and watched the videos. After watching the videos, the students performed the movements. The situation was not natural because there were four adults and four students at the small gym. Two adults were teachers documenting the activity for the school's purposes and the other two adults were researchers. One researcher took photos and another wrote down observations. As a result of the confusing situation, the students did not show much enthusiasm. QR codes will, however, remain at the gym, which will allow the students to take advantage of them later on. This time, no technical problems occurred during the test. In the upper secondary school, the students used tablet PCs to scan QR codes and watch the videos. A tablet PC's display is larger than that of a mobile phone, which made watching the videos easier.

RESULTS

Teachers' feedback

In primary school 1, the activity was mainly planned by the researcher with the help of the school's school assistant. Because of this, the two teachers made very few comments on the activity. Both of them noticed that the pupils really liked the activity. The 3^{rd}-4^{th} grade teacher said that he should do more information retrieval with his class because the students had problems with the search words. The 5^{th} grade teacher commented that the students seemed enthusiastic and that it was exciting for the students to circulate within the school as a group.

The feedback from the teacher of primary school 2 was that the experiment involved a lot of work. The teacher said that the most time-consuming part was verifying that the material is accessible on different kinds of mobile devices. The teacher said that many multimedia resources such as animations do not, unfortunately, work on smart phones. The teacher suggested that textbook publishers could locate working multimedia resources and embed them in textbooks with QR codes. The teacher also considered that QR activities worked better with mobile devices that have a larger display. However, the teacher said that the pupils really liked working this way and that their motivation was high even though the only new things were loaned phones and QR codes. Nevertheless, the teacher was very glad that with QR codes the students can return to previously taught matters whenever they want, which can promote deeper learning. The teacher is going to continue the use of QR codes and is trying to find and develop new ways to use QR codes in an educational context.

The teacher from the secondary school said that it is important to plan the QR activity well in advance. The teacher had noticed that the activity failed to motivate the students because its contents were the same outside and inside the classroom. The teacher also considered the novelty effect. Nevertheless, the teacher said that schools really need more experiments of this kind.

The teacher from the upper secondary school said that YouTube videos and QR codes can support independent learning very well. The teacher also reflected on the use of QR codes in their school and said that QR codes could be utilized in different kinds of group work as well as in homework. The teacher also pointed out that the QR codes can, in certain situations, take the attention from the substance but that they are nonetheless well worth a try.

Student feedback

The student feedback from primary school 1 and primary school 2 was very positive. 49% of the students agreed that they learned new things with QR codes and 79% somewhat agreed that they learned new things about phone use. 42% of the students somewhat agreed that they needed help with QR codes. This is because there were some technical problems with the smart phones used. (Figure 2.)

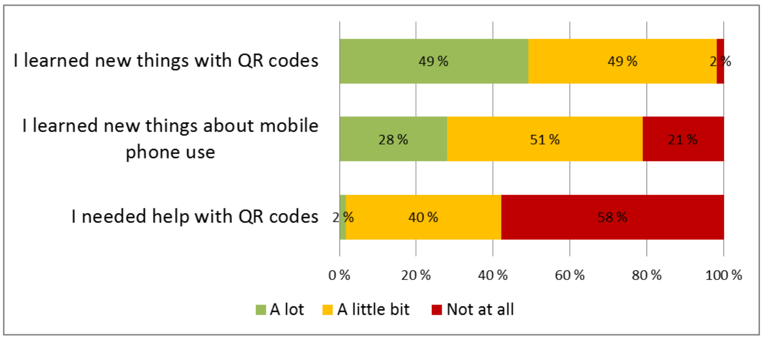

Figure 2. Primary school pupils' feedback on learning with QR codes (n=57).

67% of the primary school 1 and primary school 2 students agreed that it was easy to use QR codes and 82% agreed that it was easy to read from the mobile device's display. (Figure 3.)

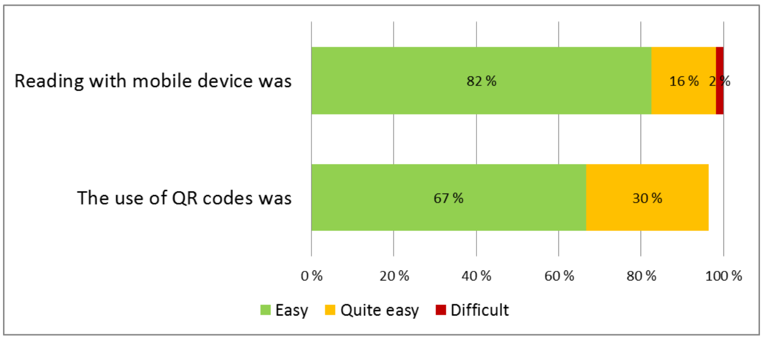

Figure 3. Primary school pupils' feedback on the use of QR codes (n=57).

95% of the primary school 1 and primary school 2 students agreed that QR activities were an interesting new way to learn and 98% of the students would like to do QR activities again. Some students had difficulties with their smart phone and this is why 30% of the students disagreed with the statement that the phone always worked as they wanted. (Figure4.)

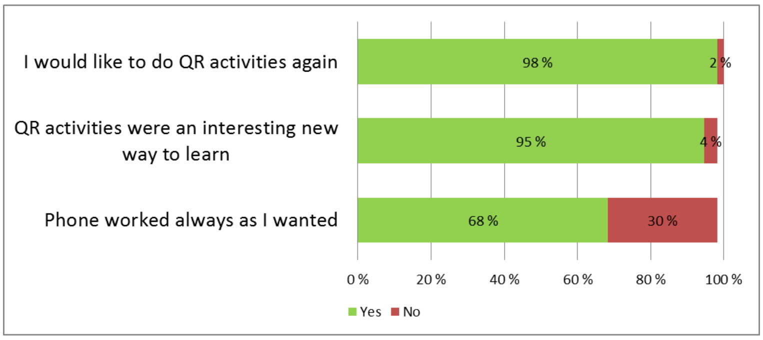

Figure 4. Primary school pupils' feedback on QR codes motivational aspect (n=57).

In primary school 1, a girl wrote that "*it was really fun even though the phone did not work very well."* Another girl wrote that "*the QR activity was a really nice variation to the normal school day!*" A boy wrote that the experiment was "*fun but I didn't grasp the idea*."

In primary school 2, a girl wrote that "*it was really fun and nice. It was nice to learn in a different way rather than by reading a book. There were some problems with the phone but it was fun!*" A boy wrote that the class was "*more fun than usually*." Another girl wrote that "*it was fun and I learned to use QR codes*."

53% of the students from the secondary school and the upper secondary school strongly agreed that it was easy to use QR codes and only 5% of the students thought that they had to learn many new things before they could use QR codes. 26% of the students strongly agreed that QR codes should be utilized more in education. 16% of the students strongly agreed that they learned new things with QR codes and the same number of students strongly agreed that QR codes are motivating. Only 11% of the students thought that QR codes are useless. 53% of the students somewhat agreed that QR codes can provide more information. What is surprising is that 37% of the students somewhat agreed that when using QR codes, the attention is drawn too much on technology. This is probably because the activity itself was not well-planned and did not motivate the students. When the activity is not well-planned, the attention of the students may be diverted to something else. Also the technical problems may have had a negative impact on motivation. (Figure 5.)

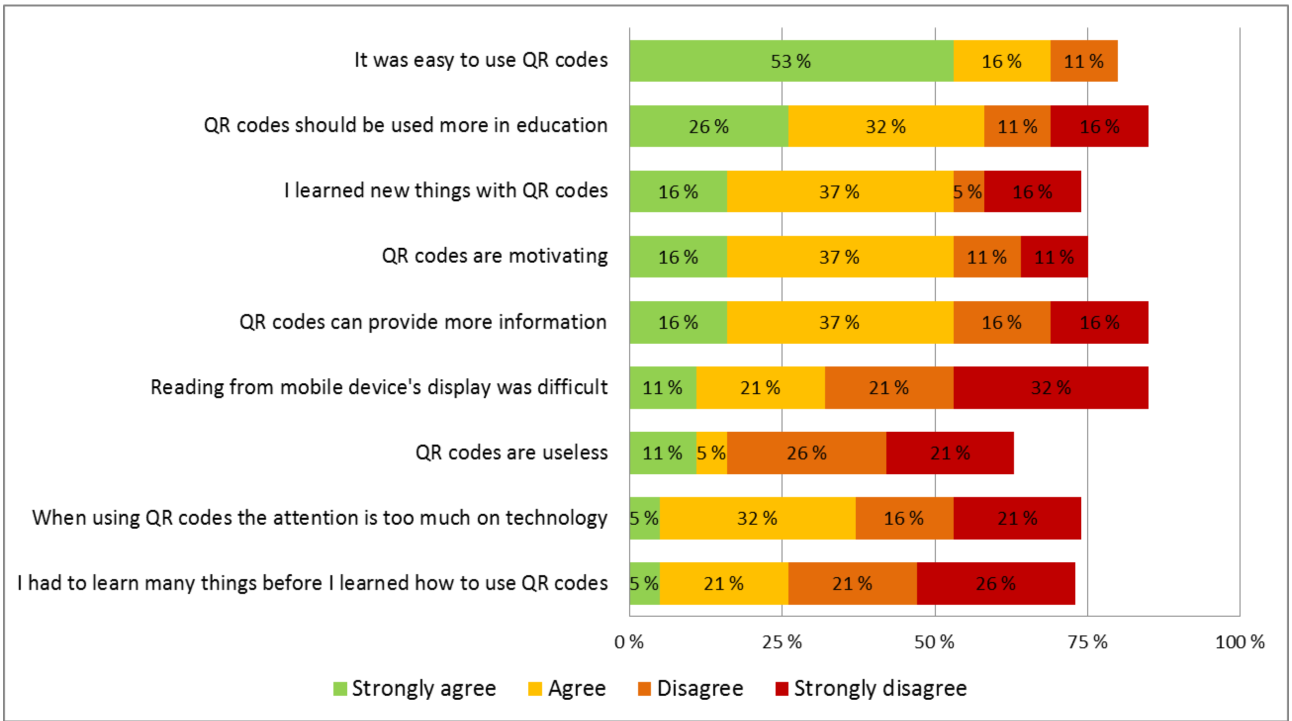

Figure 5. Secondary school and upper secondary school students feedback (n=19).

The secondary school students criticized that the contents were the same in the woods and in the classroom. A girl said that "*there is no inspiration anymore because we already planned one story in the classroom*." There were also some technical problems and afterwards the students commented that "*my phone's camera did not read the codes correctly*." In the secondary school, the students' feedback was inconsistent but slightly positive. A boy wrote that "*everyone concentrates better when the teaching is varied*." But another boy wrote that "*I think that it was a totally useless activity. It was good that we were able to go outdoors during the lesson, though*." A girl wrote that "*QR codes were a bit difficult to use but they motivate to learn and it was fun*." Another girl wrote that "*it was nicer than traditional learning*."

In the upper secondary school, the students did not show much enthusiasm. This is perhaps because the conditions were not natural. There were four adults and four students in a small gym. Nevertheless, the students did go through all the codes and made all the movements. One student said that he learned a new movement with a QR code, and also the survey showed that the students thought that they had learned new things with QR codes. The students disagreed that the attention would have been too much on technology. One student wrote that "*QR codes can tell you more than you could learn by reading a book*." One student, however, considered that the students might concentrate on irrelevant things but that at best learning with QR codes can be quick.

Technical and pedagogical challenges

Technology can bring challenges to education. The students' motivation can suffer and they become frustrated if they encounter problems with technology. The software that we used for decoding the QR codes was slightly unsteady and some students grew impatient with it. In the future it would be reasonable to test various QR code readers.

Also the scanning of the QR codes could become more difficult depending on the circumstances. In our experiments we noticed that a rounded surface can twist the code and interfere with the scanning. Also reflections, lighting and shadows can interfere with the scanning. Targeting the QR code scanner also calls for accuracy. The first QR code was always the trickiest for the students but when they learned how to use the scanner properly the following codes were much easier for them and their frustration declined.

In primary school 2 the contents did not scale to the display properly and because of this signing on to the web page and searching for the right information was a bit awkward for the students. The most notable problem was the small screen and tiny keys of the loaned equipment. The contents should be designed so that they are proper for mobile learning. Gu, Gu, and Laffey (2011) emphasized that the usable mobile learning products should be practical, micro and simple both for content and activity. Based on our experiments we can agree with this point of view.

DISCUSSION

This study explored and analysed teaching methods and processes that incorporate QR codes and mobile devices into the classroom. Our primary data indicated that with QR codes it is possible to enhance personalized, situated and authentic learning as well as collaboration, which are also core characteristics of mobile learning.

We found that with QR codes it is possible to arrange activities where students move in the field or in the community. This is consistent with Law and So (2010), Lee et al. (2010) and Osawa et al. (2007) who reported that with QR codes embedded in the environment students can obtain relevant information. Our experiments showed that with QR codes learning can happen in different contexts such as the woods, the gym, and the school surroundings. We also found that learning materials and activities embedded in QR codes can be designed so that they are contextual or location-aware, in other words relevant to the environment like the gym. Just like Law and So (2010) and Chen et al. (2010), also we found in our experiments that with QR codes it is possible to enrich paper-based learning materials. We also found that QR codes can support collaborative learning. This is consistent with the findings of De Pietro and Frontera (2012) who reported that QR codes allow the implementation of innovative systems based on the paradigm of collaborative learning.

To clarify our findings that QR codes can enhance personalized, situated and authentic learning as well as collaboration, more thorough and longer-term evaluations should be conducted. Our study has limitations. One major shortcoming of our study is that we did not measure learning effects sufficiently. We are going to examine the learning effects, especially the added value, in more detail in our future experiments. Another notable shortcoming of our study is that we did not control the novelty effect. Our future experiments would be more thorough and longer-term. For a longer-term period the bias of the novelty effect can be controlled better.

Our aim in future experiments is to find more proper educational uses of QR codes and to categorize them. We also expect that our future work will offer examples and tips for teachers on how to utilize QR codes in an educational context and that way we can promote mobile learning.

CONCLUSION

The use of QR codes in education is still in its infancy and published studies on the subject are few. We carried out five different QR experiments and explored and analysed how QR codes work in an educational context. A longer test period is required to gain more profound knowledge about their impact on learning. In our future experiments we will examine the learning effects in more detail.

In our experiments we found that teachers are somewhat sceptic about the use of QR codes in education. However, teachers who have tested QR codes in education say that they are worth a try. We found that the teachers' main feedback was that planning a QR activity is an arduous task especially when one is not familiar with QR codes and the ways to utilize them in an educational context. This might be why QR codes are not commonly used in education: it simply takes too much of the teachers' time and energy to interweave all crucial aspects together. There should be more examples and tips available to teachers on how to utilize QR codes in an educational context. In this paper, we introduced some examples and implementations of QR activities in an educational context.

Our experiments showed that it is important to take the pedagogical aspect into account when planning QR activities. The focus should be more on the learners than on the technologies used. When the focus is too much on technology and the activity is not well-planned, it fails to motivate the students and their attention may be diverted to something else. We also noticed that technical problems may have a negative impact. The students' motivation can suffer and they become frustrated if they encounter problems with technology.

Just like Law and So (2010), we also found that the students considered the QR activities to be interesting, and the students were very curious about these new approaches that deviated from their routine exercises. We found that the general perception of the students and pupils of QR codes in education was positive. They found QR codes motivating especially when the QR activity was well-planned and organised and the technology was functioning well. The students also liked getting out of the classroom. In some cases technical problems affected their motivation negatively, but, overall, the students and pupils were very enthusiastic and motivated and said that they learned new things with QR codes. In our experiments, the students also stated that QR codes brought much-wanted variation to the school day. Our experiments indicated that QR codes could be an effective way to motivate and engage students in learning but the novelty effect should be inspected in more detail.

In our study we found that QR codes can support learning in different contexts (e.g. in the woods, in the gym, within the school surroundings). Our experiments showed that with QR codes, learning can be extended beyond the classroom, and learning materials will no longer be limited to textbooks. Learning materials could be videos, texts, pictures, etc. Our experiments also showed that QR codes can support independent learning as well as collaboration.

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Heutagogial approaches to mlearning: from student-generated content to international co-production

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ABSTRACT
Mobile devices have disrupted and reinvented traditional media markets and distribution: iTunes and the iPod now rule music industry distribution channels, Twitter has reinvented Journalism practice, iTunes and the iPad are disrupting book publishing via ebooks and ibooks, and the television and movie industry are struggling to respond to the impact of iTunes, YouTube, Vimeo and mobile devices. These game-changes have also impacted and reinvented performing and screen arts higher education. We critique the changes brought about in a case study of film and television higher education from explorations of student-generated mobile movie production to facilitation of international student mobile media co-production teams supported by the development of an international Community of Practice (COP).

Author Keywords
Mlearning, heutagogy, co-production, Community of Practice (COP)

INTRODUCTION
Over the past four years the teaching of an higher education Film and Television course has undergone significant transformation as the lecturers have attempted to engage with the impact of mobile devices and new forms of media distribution on the industry. This journey has also led to significant pedagogical transformation, as the lecturers have undergone conceptual shifts in the understanding of their roles and the roles of their students in a post web 2.0 world. Many IT commentators are pronouncing the issuing in of a post web 2.0 era: not web 3.0, but the mobile web.

> Social companies born since 2010 have a very different view of the world. These companies – and Instagram is the most topical example at the moment – view the mobile smartphone as the primary (and oftentimes exclusive) platform for their application. They don't even think of launching via a web site. They assume, over time, people will use their mobile applications almost entirely instead of websites. We will never have Web 3.0, because the Web's dead. (Jackson, 2012)

Jackson (2012) postulates that Web 2.0 companies (founded from 2002 to 2009) such as Google and Facebook may fade into irrelevance in a post web 2.0 world unless these companies can make the conceptual shifts that a mobile-focused world brings. This post web 2.0 world is characterized by in situ (contextual) real-time sharing and collaboration, enabled by today's powerful mobile smartphones. It is a world where Internet use is mobile-first or even mobile-only. Mobile broadband subscriptions out-numbered wired Internet connections in 2010 (Acharya & Teltscher, 2010), the iPhone became the most popular camera used to upload photos to Flickr during 2010 (MobileFuture, 2010), and tablets such as the iPad or Kindle Fire have become a popular medium of choice for reading and media viewing. This shift is illustrated by two recent incidents:

- Facebook's flagging IPO share prices have been attributed to its weakness in mobile (Gustin, 2012; Miller, 2012). Facebook has embarked upon a mobile buying spree trying to bolster its mobile presence, such as the acquisition of Instagram.
- Obama recently made a call for all US Government services to be mobile enabled within a year, and is quoted as saying "Americans deserve a government that works for them anytime, anywhere, and on any device" (Melvin & Bull, 2012, p. 1).

This paper recounts the transformational journey that the lecturers and researcher have been on in forming a Community of Practice (COP) for reinventing a Film and Television course in response to a mobile post web 2.0 world. Key to this has been the changes implemented within an elective course on emerging technologies, that began with a mobile technology focus, but have now moved from enabling student-generated content on mobile devices to enabling collaborative design of authentic international student co-production teams. This change has been paralleled by a pedagogical shift from teacher-directed content (instructivist pedagogy) to student-negotiated and student-directed heutagogy as well as collaborative learning. Not only has the teaching paradigm been transformed, but the curriculum design process has also undergone a transformation from a course written for delivery by a sole lecturer to the co-creation of a collaborative curriculum by an international community of practice of expert lecturers. This transformation echoes Laurillard's (2012) call for teaching to become a collaborative design science.

> A 21st century education system needs teachers who work collaboratively to design effective and innovative teaching, and digital technologies are the key to making that work. Teaching is now a design science. Like other design professionals - architects, engineers, town planners, programmers – teachers have to work out creative and evidence-based ways of improving what they do. (Laurillard, 2012)

Heutagogy

New approaches to collaborative design of education such as that called for by Laurillard require new pedagogies. Heutagogy is used to describe the type of student-directed pedagogy usually reserved for the domain of post-graduate students (Blaschke, 2012). However, Hase and Kenyon (2000) argue that "heutagogy is appropriate to the needs of learners in the twenty-first century, particularly in the development of individual capability" (Hase & Kenyon, 2000, p. 1). Building on this, Luckin et al., (2010) argue that heutagogy can be seen as a progression along a continuum of pedagogical approaches from teacher-directed pedagogy to student-centred andragogy and finally student-directed heutagogy. This pedagogy-andragogy-heutagogy (PAH) continuum can be designed using mobile devices to facilitate learner-generated contexts: "The key aspect of Learner Generated Contexts is that they are generated through the enterprise of those who would previously have been consumers in a context created for them" (Luckin, et al., 2008, p. 3). The Film and Television elective projects aimed to facilitate a shift along the PAH continuum from the previously teacher-directed pedagogy of the course to a more heutagogical approach where the focus moved to student production and collaboration.

Communities of practice

Communities of practice (COP) is a social learning theory (Lave & Wenger, 1991; Wenger, 1998) that was used as the basis for supporting the Film and Television elective projects by the establishment of a learning community of the participants around each project. COPs are based upon Vygotsky's (1978) social theory of learning where learners learn from more experienced members and are gradually brought from the periphery of a learning community into its core. Thus initial peripheral observation with limited participation (or legitimate peripheral participation) is part of the process.

Mobile Web 2.0

Mobile web 2.0 leverages the affordances of mobile devices (in particular the geolocation, augmented reality, and instant creation and sharing of multimedia affordances of smartphones) to enhance the collaborative affordances of web 2.0 (O'Reilly, 2005). Thus mobile web 2.0 provides a powerful platform for enabling learner-generated contexts for heutagogy. While there are examples of mobile web 2.0 projects that leverage these unique affordances such as Cook (2010), the mlearning research literature has been critiqued for a predominant focus upon teacher-directed content delivery to mobile devices and a proliferation of short term case studies (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sanchez, & Vavoula, 2009; Rushby, 2012; Wingkvist & Ericsson, 2011).

RESEARCH METHODOLOGY

The Film and Television elective course projects were situated within a wider participatory action research (Swantz, 2008) project that investigated the potential to transform pedagogy using mobile web 2.0 (Cochrane, 2011). Each of the Film and Television elective course iterations formed a significant action research cycle within the wider research. While this paper focuses upon the context of the 2009 to 2012 Film and Television projects, the wider research has covered contexts from Architecture, Landscape Design, Product Design, Computing, Graphics Design, Accountancy, Business and Law, Civil Engineering, and Journalism (Cochrane, 2012).

Research Questions

A review of the mlearning literature led to the identification of gaps in the understanding of mlearning, and the development of the research questions, which were:

1. What are the key factors in integrating Wireless Mobile Devices (WMDs) within tertiary education courses?
2. What challenges/advantages to established pedagogies do these potentially disruptive technologies present?
3. To what extent can these WMDs be utilized to support learner interactivity, collaboration, communication, reflection and interest, and thus provide pedagogically rich learning environments that engage and motivate the learner?
4. To what extent can WMDs be used to harness the potential of current and emerging social constructivist e-learning tools?

Context

The researcher partnered with a Film and Television course lecturer establishing a lecturer community of practice (COP) within the Performing and Screen Arts (PASA) department in 2008 and 2009 to increase awareness of and create momentum for integrating mlearning into the PASA curriculum in 2009. The predominant pedagogy in the PASA department was based upon an apprenticeship model, with very high staff to student ratios, expensive computer-based video and audio editing equipment, and therefore high costs and low profit margins. These factors had led to low investment in the supporting technologies for the courses: there were no dedicated general purpose computer facilities for students, expensive video and audio computer editing suites were not networked, and the school had no wireless network coverage. Consequently teaching methods were face-to-face instruction with no integration of the wider institution's online LMS into the courses, as students had little opportunity to access online material. The researcher and PASA course lecturer therefore saw the introduction of mobile Web 2.0 into the department as an ideal opportunity to disrupt the status quo, introduce ubiquitous wireless connectivity and facilitate a move to social constructivist pedagogies using cost-effective mobile Web 2.0 technologies.

RESULTS

2009

The outcome of the lecturer COP in 2009 was the development of an ambitious mlearning project within the third year New Technologies course in semester two, involving 25 students and 2 course lecturers alongside the researcher as the technology steward. The resulting project focused upon an investigation of the potential of mobile Web 2.0 technologies within the field of Film and Television. Timetabling pressures led to a rather different mlearning project COP formation scenario than previous projects facilitated by the researcher. The project consisted of an introductory session by the researcher where the students were supplied with Dell Mini9 netbooks and Nokia Xpressmusic 5800 smartphones and given an overview of their use and the Web 2.0 applications, followed by a gap of two months, then five guest lecturer facilitated COP sessions covering the Film and TV context affordances of the smartphones within a period of two weeks (http://www.youtube.com/watch?v=00d-t0F9AzY). The COP timeframe was therefore compressed and intense. Students were very enthusiastic about the project, but tended to leave their mobile film projects to the last minute due to the pressures of all of their other final year project assessments occurring around the same time.

2010

The success of the 2009 mobile Web 2.0 project in the third year of the Bachelor of Screen and Performing Arts course drew in lecturers on the periphery of the community of practice around the project, enabling an opportunity to extend the introduction of mobile Web 2.0 across all courses of the degree program in 2010. While this was an exciting development it also represented a significant drain on the resources of the researcher and core lecturer as technology stewards across several new initiatives at once, leaving less time available for refreshing the third year mobile Web 2.0 project. The 2010 mobile Web 2.0 third-year student project was effectively a repeat of the 2009 project but the students were supplied with the much better Nokia N97 smartphone. However student expectations had changed dramatically in the 12 months between the 2009 and 2010 projects. Whereas the 2009 project represented a new experience for students with the first introduction of wifi access across the department and provision of wifi capable mobile devices, the 2010 students were not impressed with the perceived dated user-interface of the Nokia N97 in comparison to the then available iPhone 3GS and Android-based smartphones. The 2010 third year project failed to establish a sense of sustained community, with students producing mobile film projects at the last minute in order to simply meet the requirements of the course within their busy last semester of their degree. This led to a rethink of mobile Web 2.0 integration into the course for 2011.

2011

The compressed nature of the 2009 and 2010 projects did not facilitate a sustained engagement or sense of learning community formation. The 2011 mobile Web 2.0 project was therefore refocused upon a second year Film and Television course where a regular and sustained COP could be established as the basis for the mlearning integration, involving a weekly COP between the students, the course lecturer and the researcher. The lecturer-directed nature of the course has been reinvented to now focus upon a student-negotiated team-based mobile film production project. Students are supplied with a combination of either an iPhone 3G, iPhone 3GS, or iPod Touch4, and an iPad1 each. These mobile tools were then explored as mobile film creation, editing and sharing devices. The scope of the mlearning project was also extended to include a dimension of international collaboration involving the remote participation and presentation within the mlearning COP by a Film and Television lecturer in the UK with experience in mobile film festival projects. The use of Twitter and a Twitter hashtag were introduced with the 2011 ELVSS11 project. This was used for enabling communication and sharing across the time zones and distance between NZ and the UK. Real-time remote lecturer presentations were also enabled via Skype sessions projected on to a large screen for interaction with the entire class. Student response to the 2011 project was extremely positive, and some very creative student-generated mobisodes (short mobile videos) and student reflections upon the project can be viewed on the YouTube channel http://www.youtube.com/elvss11.

Elvss11

This project involved 25 Film and Television students in New Zealand producing and sharing mobile films on iPhones in collaboration with a mobile film-making specialist in the UK. The 2011 Film and television course elective "entertainment lab for the very small screen" (ELVSS11) explored team-based student-generated mobisodes (short mobile video episodes) using iPhones to capture video in unique ways, and iPad1's to edit and upload the mobisodes to YouTube. As the students were learning conventional filmmaking methodologies within their wider programme of study, ELVSS11 was an experiment in acquiring video footage with a whole new set of tools, and preparing their films for delivery in a whole new way for viewing upon mobile devices, and thus exploring a new mindset as regards their filmmaking craft. The five team mobisodes and student reflections on the project are available on the YouTube channel: http://www.youtube.com/user/ELVSS11#g/u. Using the iPhones students explored and made examples of filming techniques and positions that were unachievable via traditional film making using standard production-level digital cameras and crews (see for example http://youtu.be/GgnbWiMd2C0). They also critiqued the advantages and limitations of the small screen format (see the following student reflection for example http://www.youtube.com/watch?v=uq6YUt9UAJU). This project not only explored an innovative use of mobile technology, but also enabled the course lecturer to reinvent the course's underlying pedagogy. The course was redesigned from a set of content-delivery lectures, to developing student-negotiated and student-generated team projects that were supported by the input of a range of mobile learning experts, both locally and internationally. Each face-to-face class session involved an overview of an aspect of mobile video production, and was followed by student-led discussions (enhanced with a live Twitter feed) around the development of their mobisode projects. Class notes and outcomes were negotiated with the students and made available on Google Docs. Remote guest lecturers from Wellington (NZ) and the UK (Salford University) were brought into the class via live Skype feeds, with interaction and questions enabled via both the live and asynchronous use of Twitter (for example http://youtu.be/Q427tf8e_00). A pre-project survey of the students showed that very few were using Twitter, therefore the use of Twitter was encouraged and modelled in class by the setup of dual projection screens to enable a live Twitter stream to be shown throughout each class. This facilitated interaction with the remote guest lecturers, and provided a record of brainstroms and ideas generated during the classes. At the end of the project the guest expert lecturers recorded and shared feedback on the final student videos via ten minute VODCasts on YouTube (for example: http://youtu.be/I5ohdxS-B_k).

This project led to the establishment of an international lecturer community of practice (initially comprised of the lecturers involved in the elvss11 project, and extended by invitation to other interested lecturers) exploring the use of mobile social media within student collaborative co-creation mobile video projects such as the subsequent elvss12 project. This lecturer COP emerging out of the elvss11 project was sustained using Twitter and Google Plus Hangouts as core communication tools, and Google Docs as a collaborative platform for collaboratively designing the elvss12 project.

Elvss12

This project built on the ELVSS11 project to launch an international student mobile film co-production project involving student teams in New Zealand, France, and the UK, (http://elvss2012.wordpress.com/participants/). The ELVSS11 project established partnerships with like-minded lecturers around the world, which in turn led to developing the elvss12 project as an international collaboration, initiated and managed by the PASA course lecturer. Thus in 2012, the elvss project became a three-country collaboration, including students from Unitec in Auckland, New Zealand, Salford University in Manchester, UK, and from Université de Strasbourg in Strasbourg, France, with a total cohort of 37 students.

There were two main projects in which the students engaged: 24 Frames 24 Hours, and Mobile In, Global Out. "24 Frames 24 Hours" is a regularly occurring international collaboration in which people capture footage representing a two-hour slice out of a pre-set 24-hour period. They then cut that footage down to a two-minute film and posted it on the 24 Frames 24 Hours Vimeo.com channel. ELVSS participants contributed to this effort individually, as an introduction to the concepts and the practice of collaborative mobile video production. "Mobile In, Global Out" was the major project of ELVSS12, where students formed four global teams, to create four different mobile movies that addressed the topic of environmental sustainability. Each team consisted of nine members: 2 New Zealand members, 5 UK members, and 2 French members. Each team chose from a provided list of sustainability sub-topics to address and also from a list of story genres through which to shoot. The main collaboration tools used by the teams included: Google Docs, Google+ Hangouts to facilitate a global team that bridged the timezones between the three countries. Google Docs has more specifically facilitated the heutagogical approach of this project via involving and their empowering the students in updating and changing submissions deadlines as well as meetings and feedback dates and times with all the lecturers. In these synchronous and asynchronous meetings, they co-wrote the movie script they would be making. The requirements for each team's movie were to be comprised of three sections: a NZ section, a UK section and a France section. Each team was to shoot and edit their own section that was then edited into one central story concept. Teams shared their mobile video footage – both within the team and between teams – using a shared 100GB Dropbox account. The final edited versions were posted to the ELVSS12 YouTube channel http://www.youtube.com/elvss2012. A summary of web 2.0 activity associated with the project was collated via a Google Reader Bundle (http://tinyurl.com/7hbmm25), providing a simple summary of the reified activity of the ELVSS12 student COPs for the lecturers to track.

At the end of the project, the project mentors (the ELVSS12 lecturer COP), including the technology stewards and the lecturers associated with the project, viewed the final versions and gave reflective feedback on video to the students on their individual pieces. Unitec students edited their sections on their iPads so the NZ portions were fully mobile in their creation. The other participating students used their own personal mobile devices for the project. All of the students participated in the creation of a group Wordpress blog for their team movie project, and most of the students also kept a personal WordPress blog, journaling their ELVSS12 experience. These included personal video podcasts that reflected on the process and how their view of filmmaking was transformed by this experience. Examples of these are collated in the ELVSS12 YouTube channel. What was different about the ELVSS12 project in comparison to the previous three iterations of the Film and Television elective was that students from different disciplines and different countries participated in an authentic international collaborative project enabled by mobile and social media. The students also had more ownership of the assignment in deciding collegially about its content, its style, creating a shift along the pedagogy-andragogy-heutagogy (PAH) continuum. The final four videos can be found on the project blog: http://elvss2012.wordpress.com/projects/.

DISCUSSION

The four iterations of the integration of mlearning into the Film and Television course have evidenced a progression from an initial focus upon the affordances of mobile devices to the establishment of student-negotiated projects within international co-production teams. The culmination of these project iterations have led to the development of an international community of practice of mobile media lecturers and experts, and reified in the ELVSS12 project. Thus we explore the ELVSS12 project in more detail here.

Table 1 provides a summary and comparison of the four iterations of the mlearning project within the Film and Television course.

Year	**2009**	**2010**	**2011**	**2012**
Project Title	New and Emerging Technologies	Visual Media Technologies	ELVSS11	ELVSS12
Project Hub	Blackboard	Blackboard	Moodle	Wordpress
Participants	N=25 students N=3 lecturers	N=20 students N=3 lecturers	N=20 students N=3 lecturers	N=37 students N=6 lecturers
Mobile Devices	Nokia Xpressmusic 5800 and Dell Mini9 netbooks	Nokia N97 and student-owned laptops	iPhone 3G and iPad1	iPod Touch and iPad2, student-owned smartphone
Pedagogy	Andragogy	Andragogy	Heutagogy	Heutagogy
Project Focus	Mobile Device affordances	Digital Identity	Co-production	International co-production
Web 2.0 Tools used for collaboration	Vox Ning Qik Livestream	Typepad, Blogger or Wordpress Ning Qik Livestream	Wordpress Twitter Qik Skype	Wordpress Dropbox Twitter Facebook Google Plus
Outputs: YouTube channel **http://www.youtube.com/user/**	09unitec	UnitecPASA10	ELVSS11	ELVSS12

Table 1: Comparison of four project iterations

Figure 1 illustrates the interrelationship between the ELVSS12 lecturer community of practice and the three student cohorts in New Zealand, the UK, and France. Figure 1 shows the key mobile web 2.0 tools used by the lecturers to facilitate international communication and collaboration at the intersecting boundary points of the four communities of practice involved in the project: the foundational lecturer COP that included three course lecturers and three mobile media experts, and the three course cohorts situated in each country. These tools included: Twitter, Google Docs (now Google Drive), Facebook, Soundcloud, Wordpress, Google Plus, and Dropbox. These tools were chosen because of their support for multiple devices and the fact that they each have an excellent free mobile application. The use of these tools reified the activity and flexibility of the ELVSS12 lecturer COP, resulting in the production of boundary objects that were then used by the participants to broker the concept of an international co-production project to the three groups of students, and to anyone interested in following the progress of the project. This structure became a model for the four international student teams and enhanced students' engagement in general. While initially invisible to the students, the ELVSS12 lecturer COP that formed the foundation for the project was made explicit to the students by three reified activities of the COP: firstly by lecturer commenting and participation in the student team projects via mobile social media (such as Twitter, and Facebook discussions), secondly by two scheduled group Google Plus Hangouts (http://tinyurl.com/8w52vy2), and finally by the invitation of student representatives from each team to participate in the last few ELVSS12 lecturer G+ Hangouts (http://tinyurl.com/cjgqpye).

Figure 1: Brokering the ELVSS12 lecturer community of practice

There is still much room for improvement in the next iteration of the ELVSS project. The greatest student outcome of the ELVSS12 project was their international co-production team experience. In comparison to the ELVSS11 videos, there was little evidence of engagement with the unique affordances of mobile devices in their movies. For example the ELVSS11 teams created movies that featured QR Codes, and experimental shots and production techniques that were unobtainable using larger conventional production film cameras. Mobile devices were certainly used extensively for international collaboration via Twitter and Google Plus Hangouts, Facebook chat and text messaging. However the effort required to establish and nurture these international teams meant that there was less time for creative effort to be put into the mobile film production itself. It took time to bring all of the student participants from legitimate peripheral participation within the project COP into full participation. This COP development timeframe needs to be designed for within the course structure. The four iterations of the Film and Television elective (2009 to 2012) have all illustrated the need to design significant time within the projects for students to appropriate the educational use of mobile web 2.0 for collaboration and communication. The main limitation with international collaborative projects between the northern and southern hemispheres is the complete inversion of the academic year between the two, making coordination of project timeframes very difficult. Google Docs were used by the lecturers to map out critical timeframes and events around the ELVSS12 project. This needs to be done at least six months in advance before the start of such a project to allow synchronisation of times within the collaborating courses.

ELVSS12 student reflections

As part of the project students were asked to provide a reflective blog post at the end of the project. Representative student posts are shown here.

> I feel that the whole module was a good experience in that it allowed communication and ideas to progress through the use of social media from one side of the world to the other. I feel that this process has many advantages and possibilities because it allows you to learn from people from other cultures and share you ideas to produce something that is unique. The whole group, ours and the other groups worked extremely well as a whole to produce their films and I think everyone gained something from doing this exercise. (Student1, 2011)

> The main thing really to my experience is that doing this project with people from UK, France and New Zealand, there is that CONNECTION ... and RELATIONSHIP that has been established with everybody.

A sort of bonding that is unique in a sense and that I believe is very important " That is Social Tech, Peer and Experiential Learning ". (Student2, 2011)

Students were particularly appreciative of their international team experience during the ELVSS12 project, and the sense of participation within a community with a similar vision spanning three countries. The fact that the student expressed some positive feelings about the advantages and possibilities of the process is supporting the focus and the use of heutagogy as a key methodological approach.

ELVSS12 lecturer reflections

Lecturers also provided reflective feedback on the project in the form of videos for the student teams to watch, and personal blog posts.

> What's quite beautiful is the shift towards an emergent CoP model where learners are gradually taking on responsibilities and becoming coordinators...
>
> With ELVSS12, it's about the lived experience – it's the students who are experiencing this collaboration, alongside us as lecturers. The boundaries become blurred however. We start to meet one another's friends/families (in the spirit of the project we may hangout any place/any time). It's beautiful.
>
> ELVSS12 is also about learning through frustration (at least, I think it is). To hear the students speak so eloquently about international communication and collaboration from a distance, and with such deep understanding of the issues, I do believe that even if the films are maybe not so polished as they had hoped, they've actually taken away something much more valuable from this collaboration – the ability to collaborate, co-create, coordinate a major project with people that they have never met.

The sense of relationship created by the use of mobile web 2.0 tools throughout the project was one of the strongest themes running through both the student and lecturer reflections on the ELVSS12 project. The brokering of the lecturer COP to the student teams via the participation of student team representatives in the weekly Google Plus hangouts made the sense of partnership, relationship, and collaboration that the lecturers had built up explicit to the students. We need to note also the "frustration" which is one of the key components of the pedagogy-andragogy-heutagogy (PAH) shift: while flexible and reactive, this approach can generate frustration and tension as students reconceptualize their role as active participants and self-directed learners.

Recommendations for the future

In keeping with the heutagogy theme of the paper, recommendations for future iterations of the ELVSS project came from the students themselves. The following are ten student recommendations that serve as discussion points.

> 10 Tips for the Next Time
>
> 1. Same start dates if possible would be ideal
>
> 2. Smaller groups are easier to manage
>
> 3. Clearer assignment of stuff to do
>
> 4. Group representatives should be appointed at the start
>
> 5. Global platform for blogs, data, rushes, and text
>
> 6. Maybe 3-4 platform to use Facebook, Dropbox, Google Hang-out, Youtube, Twitter
>
> 7. A guidance note given in advance for example after the groupings been done and representative
>
> appointed. First thing would be FACEBOOK LINKS AND EMAILS for every group member.
>
> 8. Groups to establish proper delegation of responsibilities.
>
> 9. All work should be marked doing the project so that everybody participates and not just don't care.
>
> 10. Tell all students to buy their own mobile phone with a camera on it. (Student blog post, 2012)

Some of the key issues (1,9) raised in this student feedback relate to managing the difference in course start dates, assessment deadlines, and semester breaks between three different countries – this will always be difficult to manage, but not unsurmountable with appropriate pre-planning. Other issues identified by students relate to the scaffolding of heutagogical paradigm used within the project (3,7). Students need time to develop the teambuilding and collaboration skills required to make the co-production teams successful (2,4,8). These teams need to leverage the skills of the participants, identifying early within the project a team leader, and assigning production roles appropriately to team members. A set of common web 2.0 tools for collaboration needs to be agreed upon by all of the teams (5,6,7). Finally the projects need to focus upon student-owned devices for creating a sustainable approach within a variety of contexts where a common device platform is practically impossible (10). Providing students with an authentic international co-production team experience takes these students beyond their previous learning experiences that have largely been within teacher-directed or andragogical paradigms. However founding the projects within a supporting community of practice of expert international lecturers provides a framework to scaffold these paradigm shifts.

CONCLUSIONS

The investigation of the impact of mobile devices on the Film and Television industry led to the transformation of an elective course from a series of teacher-directed lectures to the nurturing of an international community of practice of expert lecturers who collaboratively design a curriculum that enables students to form international mobile co-production teams. This represents a pedagogical shift along the PAH continuum from teacher-directed pedagogy to student-negotiated heutagogy. The Film and Television elective projects have leveraged the ability of mobile devices to enable student-generated content, and facilitate collaboration and communication across geographical and timezone boundaries. The 2012 iteration of the project has created the foundation of an international lecturer COP that provides a model for future international collaborative projects.

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A Three-level Evaluation Framework For a Systematic Review of Contextual Mobile Learning

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ABSTRACT

The rising popularity of contextual and location-based mobile learning in recent years calls for serious evaluation methods about learning efficacy both in formal and informal settings. Although several empirical studies give evidence showing the effects and effectiveness of mobile learning in general, there remains a lack of evaluation models that examine the efficacy of contextual mobile learning. This paper aims to build a holistic evaluation framework on contextual mobile learning and to apply the framework to evaluate previous empirical research by conducting a systematic review. The proposed framework has three levels: (a) the external level consisting of social, cultural, and technical factors; (b) the inter-medium level consisting of content, context and device; and (c) the internal level focusing on learners‟ attitude and experience. The analysis of 28 empirical studies on contextual mobile learning was conducted through a comparison and contrast method at all three levels. The review revealed that most of the previous studies conducted evaluation at the inter-medium and the internal levels, and there is lack of investigation on factors at the external level. In conclusion, we discuss the significance and implications of integrating all three levels in examining the efficacy of contextual mobile learning research.

Author Keywords

Contextual mobile learning, evaluation framework, social-cultural factors

INTRODUCTION

Mobile learning research in recent years has shifted its focus from theoretical to practical and integrated issues. Brown et al. (2010) propose that mobile learning is not only about the mobility of the learners and devices, but also the mobility of learning across contexts. According to Hansen and Bouvin (2009), "Learning does not occur in a void: it is by its very nature contextualized, and it is by linking and applying new knowledge and experience with the context of what is already known that learning is achieved" (p.19). Likewise, Pachler et al. (2010) posit that context in location-based mobile learning can be seen as interactive negotiation by the learner with their natural environment. Simultaneously, the nature of learning is being augmented and accelerated by new digital tools and media, which provide adaptive supports to the learners while sensing the personal and environmental contexts (Hwang, et al., 2009; Pachler et al., 2010). Context-aware computing technology can be used to support contextual learning in various environments such as field trips and virtual reality (e.g., Forsyth, 1986; Hwang, et al., 2009; Michie, 1998; Patten, et al., 2006).

From the pedagogical perspectives of mobile learning, we employ situated learning and contextual learning as theoretical frameworks for this study. Situated learning theory posits that learning is situated within authentic activities, context, and culture. Learning is more likely to take place when information is contextually relevant to the learner and when information can be put to use immediately (Lave & Wenger, 1991). A few scholars have constructed such theoretical perspectives on contextual mobile learning that emphasize the situated nature of human interaction and learning. For example, Tan et al. (2011) propose the 5R adaptation concept for location-based mobile learning which is stated as follows: at the right time, in the right location, through the right device, providing the right contents to the right learner. Likewise, Tan and So (2011) developed the „FAT‟ (Facilitation - Activities - Technology) framework to guide the design of contextual and location-based mobile learning. Those frameworks are applicable to the evaluation of the situated aspects of mobile learning, mobile application design, intervention plans (mostly on learning content) or contextual influences. With respect to more comprehensive evaluation of contextual and situated mobile learning, there are several good practices such as the FRAME model developed by Koole (2009) and the M3 evaluation framework proposed by Vavoula et al. (2009). The FRAME model refers to psychological concepts such as Activity Theory and emphasizes on the role of mobile devices. This model helps practitioners reflect on their mobile learning approaches and assess the extent to which learners are engaged in balanced and effective mobile learning experiences (Koole, 2009). The M3 (micro-, meso- and macro-levels) framework can be used to evaluate the technology development process, from the very early stages of design to the final assessment of the technology in a learning context. Considering the lack of evaluation models that examine the efficacy of contextual mobile learning from situated learning perspectives, this paper aims to build a holistic evaluation framework on contextual mobile learning and to apply the framework to evaluate previous empirical research by conducting a systematic review.

THREE-LEVEL EVALUATION FRAMEWORK

In the FRAME model, Koole (2009) considered a three-way relationship between mobile technologies, human learning capacities, and social interaction in the process of mobile learning. We broaden this conceptualization by examining contextual mobile learning at three inter-related levels (see Figure 1). Social, cultural and technical factors are taken into consideration at the external level; content, context and device at the inter-medium level; the learners‟ attitude and experience at the internal level. „Context‟ in this paper refers to the combination of people, the environment and the interactions amongst different people as well as the interactions between people and the environment. It is a dynamic and interrelated system since any part of which, influences every other part. In the proposed framework, the elements of context would be integrated into each level, and all the three levels are influencing and are influenced by each other. In other words, the context of contextual mobile learning in this paper has different meanings at different levels. We describe the details of three-level components in the section below.

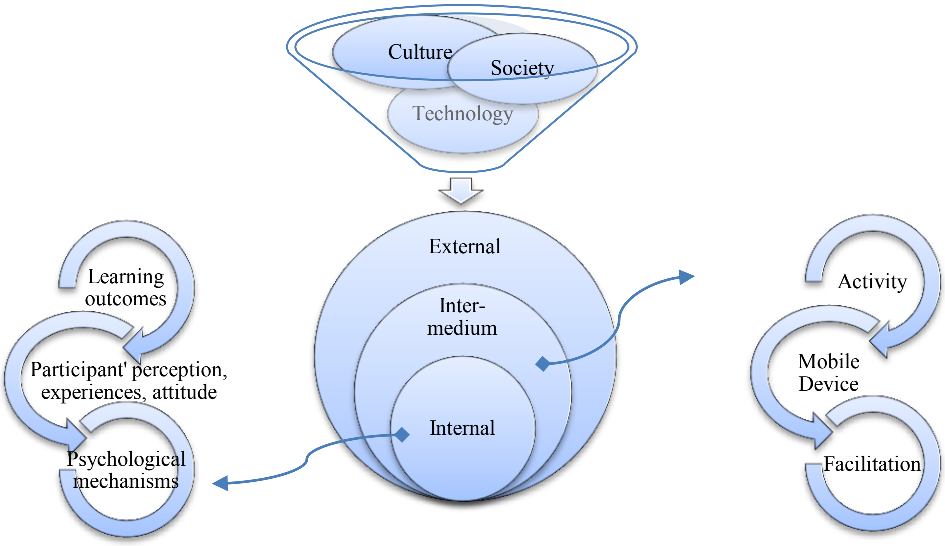


Figure 1 Three-level evaluation framework for contextual mobile learning

The External Level

Context at the external level refers to cultural readiness, societal maturity, and technological advancement. Inter-related technological, social, and cultural changes are affecting the content and the context of learning in our daily life. Technological advances make information readily accessible and can support contextual mobile learning in novel ways. Now anyone with an Internet-enabled cellphone can access databases of texts, videos and audio information on the go (Klopfer & Squire, 2007). Anyone can learn across physical contexts and time scales with the affordance of mobile technology and web-based applications (So et al., 2010). Social interaction and collaboration are also essential components of contextual mobile learning. Boticki et al. (2009) argued that community is one of the contextual dimensions to be considered in designing context -aware technology applications, and a knowledge sharing culture is needed in a community of learners for effective contextual mobile learning.

The Inter-medium Level

Context at the inter-medium level consists of the specific aspects and issues that are relevant in the design of and the implementation of mobile learning activities. Context at the inter-medium level is filtered from the external level and is situated at a certain level of social acceptance, technology advancement, and cultural support. Based on the conceptual framework for the design of situated learning environments by Choi and Hannafin (1995) and the „F.A.T‟ framework developed by Tan and So(2011), three aspects are included at the inter-medium level: (a) activity design in terms of different types of context and content, (b) facilitations, and (c) the use of mobile devices.

First, referring to the two-dimensional framework of mobile learning space by So (2008), and to the notion of context proposed by Breuer and Matsumoto (2011), the type of context could be identified by whether the environment is a closed space (e.g., a museum) or an open space and whether learning occurs in a virtual-world (e.g., augmented reality) or real-world. Context can also be a combination of any of the above, since some mobile learning studies attempt to do seamless learning or ubiquitous learning by bridging formal and informal learning with the use of both real-world and digital-world resources. The type of content can be categorized by different subject areas (e.g., science, social studies, etc.) learned or experienced in a mobile learning context. Second, facilitation refers to „Who‟ facilitates „What‟ and „How‟ in a specific mobile learning context. Facilitators can be human, computers, a combination of both, or even self-directed learners. Computer-mediated facilitation can be divided into asynchronous and synchronous communication amongst participants in a mobile learning scenario. In terms of „What‟, facilitation can be used to guide content knowledge, soft skills, and logistical or technical issues. „How‟ refers to facilitation methods, which consist of modeling, scaffolding, coaching, collaborating and fading as well as using cognitive tools and resources (Choi & Hannafin, 1995). Lastly, mobile devices refer to the various technological tools that are used in mobile learning, such as PDAs, tablet PCs, mobile phones, and pocket PCs. The role of mobile devices can be seen from the pedagogical framework model by Park (2011) in which individualized and socialized activities are mediated by asynchronous and synchronous communication. In this paper, the interplay among activity design, facilitations and the use of mobile devices in the evaluation of contextual mobile learning will be discussed with specific cases reported in previous research.

The Internal Level

Context at the internal level reflects learners" experiences, attitudes and perspectives. Context at the internal level is influenced by the environment at the external level and is situated within the frame at the inter-medium level. Positive and negative effects on the learners from the other two levels should be systematically and critically investigated at this level to evaluate contextual mobile learning. Evaluation of the learners" aspect can be conducted along the dimensions of learning achievement, learning attitude, cognitive load and perception of the mobile learning system (Yang & Lin, 2010; Hwang et al., 2010; Wu et al., 2010). In the FRAME model by Koole (2009), individuals" cognitive abilities, memory, prior knowledge, emotions, and possible motivations are included in the learner aspect. In terms of device usability, psychological comfort affects cognitive load and the speed with which users can perform certain tasks (Koole, 2009).

This paper categorizes evaluation at the internal level in terms of learning outcomes, participants" attitude, perception and experiences, and psychological mechanisms. Here psychological mechanisms refer to cognitive tools that are integrated into mobile learning systems or curriculum designs. The adoptions of these cognitive tools are based on prior psychological studies with both technological and pedagogical concerns. For example, in Wu et al. (2012), the cognitive apprenticeship strategy and a context-aware ubiquitous learning environment are combined in nursing skill training during which students are provided with both personalized guidance and instant feedback and supplementary materials. In Zhang et al. (2010), by adopting the metaphor of deconstructing and reconstructing, a collective curriculum mobilization cycle comprising of six steps, namely, deconstructing, brainstorming, composing, reconstructing, implementing and summative evaluating, is developed for both in-class learning and out-of-class learning. The effects of those cognitive tools on the learners can be either positive or negative: positive effects can be improvement in learning effectiveness and learning attitude while negative effects could arise from information overload and increased cognitive load.

METHOD

Inclusion and Exclusion Criteria

Given that there is lack of holistic evaluation frameworks on contextual mobile learning, the systematic review was conducted to analyze previous empirical studies published in journals. A two-step literature search was conducted from February 2012 to April 2012 for this review. First, we began with search terms such as „location-based and/or contextual mobile learning", „context aware mobile learning", „situated mobile learning". A comprehensive search was done in the following databases: (a) ERIC via EBSCO, (b) EdITLib, (c) Education Research Complete, and (d) Ingenta Connect. Second, references in the articles were searched using the „snowball" method. Articles surfacing only theoretical models, the designs of new architecture or products, or literature reviews, were excluded.

Data Extraction

The following data were extracted from the selected research articles: author names and date of publication, sample size, subject areas, research design, and study focus, learning design, mobile devices and facilitation. An in-depth coding process was carried out for the selected papers according to the three-level evaluation framework and the coding scheme (see details in Table 1). Elements at the external level are not included in the coding scheme since they are intangible factors and are rarely mentioned in the selected research papers.

Variable	Description	Coding Criteria
Year	Year study was conducted	Year
Population	Sample population	P – Primary; S – Secondary; H – high school; UG – Undergraduate; Gr – Graduate; Others
Sample size	Size of sample population	Leave blank or actual number of subjects
Subject area	Content area taught	L – Languages; S – Natural Sciences; SS – Social Sciences; Math – Math; Others
Methodology	Research method used	Quantitative; Qualitative; Mixed methods; Others
Focus of study	What was the main focus of the study in terms of evaluation/evaluation?	LO –Learning outcomes; PAPE – Participants" attitude, perspective and experiences; PM – Psychological mechanisms Others
Learning design	Type of learning context	Open; Close; Virtual; Real; Others
Mobile device	What kind of mobile device is used?	MP – Mobile phone; PDAs – PDAs; PPCs – Pocket PCs; TPCs – Tablet PCs; DC – Digital cameras; DVD – DVDs; Others

Facilitations	Who	Human; Computer; Both human and computer; Self-directed; Others
	What	CK – Content knowledge; SS – Soft skills; TS – Technical support; LS – Logistic support; Others
	How (Facilitation methods)	Modeling; Scaffolding; Coaching, guiding, and advising; Collaborating; Fading; Using cognitive tools and resources; Others

Table 1. Coding of research papers reviewed

RESULTS

Twenty-eight papers (indicated with * in the reference section) met the inclusion criteria for the current review on the evaluation of contextual mobile learning. The subject area and sample population of the reviewed papers vary greatly. These papers were similar in scope, but addressed a range of different aspects of evaluation and adopted a variety of methodological approaches. To organize the selected papers for a closer examination, different categories were created depending on the adopted research methodology and the main research focus of each paper by means of a constant comparison method. The categories used and the number of papers under each of these categories are shown in Tables 2 and 3 respectively.

With respect to research methodology types used in the 28 articles, we found that mixed methodology is more frequently used than either quantitative or qualitative methodology alone (see Table 2), Reliability and validity measures are rarely reported (n=3) or inconclusive due to small sample sizes or short intervention period in several articles.

Research Methodology			
Quantitative	Qualitative	Mixed	Total
5	5	18	28

Table 2. Number of papers in terms of research methodology types

Focus of Study	**No. of Studies**
Learning outcomes	21
Participants‟ attitude, perceptions, and experiences	12
Psychological mechanisms	2

Table 3. Number of papers in terms of the focus of research study

As shown in Table 3 (each paper may have more than one focus of study), most of the papers conduct evaluation at the internal level, with respect to learning outcomes (n=21); participants‟ attitude, experiences, and perspectives (n=12). Regarding psychological mechanisms, only 2 papers reported the psychological concerns and indications in the designs and implementations of contextual mobile learning. Overall, this review found that despite the fact that activity designs and facilitations are explained in several papers, most of them focus their evaluation on the effectiveness of technical systems or platforms. At the external level, four papers mentioned social-cultural factors (Huang et al., 2010; Klopfer & Squire, 2007; So et al., 2010; Tan et al., 2011). Two papers (Pfeiffera et al., 2009; Vavoula et al. 2009) conducted evaluation across multiple levels using the M3 evaluation framework.

Evaluation at the External Level

Evaluation at the external level aims at gaining deeper understandings of why the development of contextual mobile learning varies from cultural, societal, and technological perspectives at a macro level. Although some frameworks on contextual mobile learning have taken into account both technical and social aspects (e.g., FRAME from Koole, 2009; Context Hierarchy from Lonsdale et al., 2004) and socio-cultural factors (e.g., So et al., 2010), there is no clear evaluation method at the external level thus far. Cultural readiness in schools plays significant roles in the implementation of mobile learning activities and the use of mobile technologies. Enculturation towards contextual mobile learning is challenging, considering the dominant paradigm of education in schools that mainly focuses on the mastery of vast content knowledge at the abstract level (So et al., 2010). In the social context, field experiences mediated by mobile technologies can help learners become more connected with social networks based on friendship, collaboration, and information exchange (Huang et al., 2010).

Evaluation at the Inter-medium Level

Evaluation at the inter-medium level is to investigate how contextual mobile learning is implemented under a certain cultural or social situation. In contextual mobile learning, students are guided not only to learn with mobile devices in authentic contexts (Uden, 2007; Hwang, Tsai, & Yang, 2008), but also to generate location-based or context-specific content in the process of learning. In the context of collaborative mobile learning, the intricate relationship among task design, facilitation and the discourse types was investigated in Tan and So (2010). In their study, activity design includes structured and unstructured learning activities. Both content and context are measured along different dimensions. Facilitation, on the other hand, is assessed in terms of „who‟, „what‟ and „how‟. Because an evaluation framework in this paper is not technology-centered and we believe that the main barriers to developing contextual mobile learning are more social than technical (Sharples, 2010), our analysis places emphasis on evaluation in terms of activity design and facilitation types.

Evaluation In Terms of Activity Design

Learner-centered activity calls for unstructured engagement more than structured engagement. Although structured tasks are still needed for guiding learning process (Hsiao et al. 2010; Tan & So, 2010), unstructured activities should also be included in the mobile learning design to provide space for more self-directed learning. In Rogers et al. (2004), the learning activities were designed in a much less structured fashion compared to task-oriented field trips in order to promote more independent and student-initiated scientific inquiry. In Huang et al. (2010), learners spent roughly a half of the course time for various activities, interacting with their peers, the environment, and the course instructor. In Shih et al. (2010), learning content and activities related to the historic site and teaching were designed and carried out at three learning stages to support students‟ cognitive learning, and to increase their inquisitive learning ability. In So et al. (2009), various repairing strategies were made after a pilot study to improve learning scenarios and to make the activities less structured and cater to the students‟ self-directed interest in contextual mobile learning. The type of context can be sorted by whether the learning environment is a closed space or an open space and whether it is in virtual-world or real-world. For example, in Cheverst et al. (2000), GUIDE, an intelligent electronic tourist guide system, was used to present city visitors with information tailored to both their personal and environmental contexts. This mobile learning environment is in an open space with the integration of real and virtual resources. In Shih et al. (2010), learning activities were designed between the field and the digital system to demonstrate the practices of mobile learning and to provide digital learning contents to facilitate students‟ field studies. Learning activities took place in a temple, thus the type of context is an integration of real and virtual in a closed learning space.

Evaluation In Terms of Technical Support

As mentioned before, technological support in the 28 papers are categorized by different mobile devices. The evaluation of technical support is not only about mobile devices but also about learning platforms/systems. As an example, the evaluation of Myartspace (Vavoula et al., 2009) focuses on three levels following the M3 evaluation framework, which is also adopted in the study by Pfeiffera et al. (2009) about fish biodiversity learning via mobile devices in a situated learning scenario.

Evaluation In Terms of Facilitations

In the analysis of the 28 papers, we find that facilitations are mostly explained and coupled with descriptions of activity designs or learning processes. In Shih et al. (2010), there was a warm-up activity (i.e., PDA orientation) before the first stage activity designed to provide the students with basic knowledge, and to stimulate their learning. In Hsiao et al. (2010), facilitations are provide at four stages of learning to arouse student interest in the tasks, to increase their sensitivity to the environment, and to have them experience a natural environment and develop self-awareness with joy. As argued by Tan and So (2010), too structured facilitation would influence learning outcomes leaving little space for learners to exercise reflective thinking skills. Facilitations are categorized in terms of „who‟, „what‟ and „how‟ in this paper. In terms of „Who‟, facilitators in most of the studies are the combination of both human and computers. Human and computer are facilitating in different ways from different aspects. For example, in Wu et al. (2012), technical support was given by human facilitators whereas helpful content knowledge was provided by computers. In terms of „What‟, facilitations in most of the studies are about content knowledge; 11 out of 28 papers discussed technical support and 2 papers about logistical support. In terms of „How‟, guiding is used in almost all the studies, and scaffolding is also widely used as a facilitation strategy.

Integration of Facilitation, Activity, and Technology

Through the categorization of 28 papers, we found that the three aspects of *facilitation, activity* and *technology* are highly inter-related. They influence each other, and the balance among them is reached in a few studies. For instance, Shih et al. (2010) employed an inquiry-based mobile learning approach with the use of PDA and designed learning activities between the field and the digital system. Computer and people are both facilitating the students by scaffolding, guiding and using cognitive tools. Cognitive load is also considered in the design of the digital system and in the implementation of learning activities. Likewise, in Wu et al. (2012), a cognitive apprenticeship strategy was built into a mobile system for physical evaluation in nursing skills training. The system has a fading function where the amount of support is gradually reduced to the students if their knowledge or skills have achieved at some pre-determined levels. Technical support and helpful content knowledge were provided by human and computer facilitators. The results show that both knowledge and skill levels were promoted effectively.

Evaluation at the Internal Level

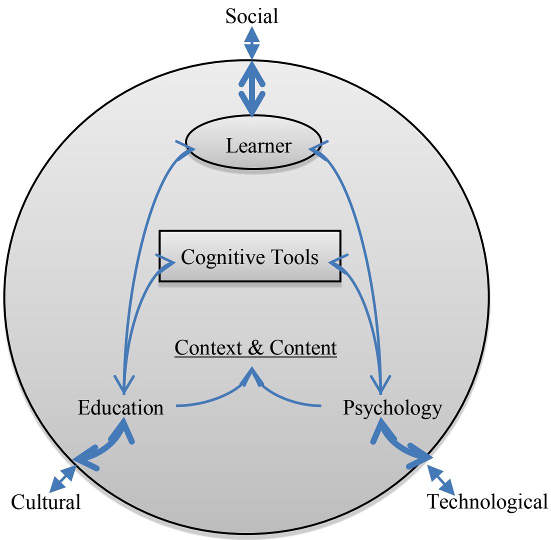
Evaluation at the internal level focuses on the learners. It aims to examine learning efficacy at both individual and community levels and how learners are situated in different contexts of mobile learning. As seen in Table 3, 21 papers focus their evaluation on learning outcomes, and 12 papers on participants‟ attitude, experiences and perspectives. The twelve studies carried out the evaluation from students‟ perceptions and learning outcomes, regarding the usability of mobile technology (e.g., Hwang et al., 2011; Wu et al., 2012; Yang and Lin, 2010). Only 2 papers illustrated the psychological mechanisms situated in their mobile learning designs and pedagogical implementations. Statistically positive outcomes are found in all 28 papers. For example, in Chen et al (2008), students‟ understanding of the 3Rs

(Reduce, Reuse, Recycle) and their understanding through the application of the 3Rs concepts were improved with the affordance of technology as well as cognitive and pedagogical tools (learning outcomes and psychological mechanisms). In Huizenga et al. (2009), with the assistance of the new mobile learning platform, both the learning efficiency and the learning achievement of the students were significantly improved (learning outcomes). In Hsiao et al.‟s study (2010), the results showed that the experimental group outperformed the control group on the ecological knowledge test. Furthermore, the students in the experimental group felt satisfied with the ecological learning system supported by positioning systems (participants‟ attitude, experiences and perspectives).

DISCUSSION

Integration of Three-Level Factors

Evaluation at each level is independent yet closely related to the other two levels. Technology, mediation of individualized and social activities in contextual mobile learning are integrated with activity design and facilitation. All three aspects should serve to meet the learners‟ needs. Pedagogical concerns and the use of cognitive tools are influencing and being influenced by learners‟ attitude, perspectives, and experiences as well as learning outcomes. Implications from psychological studies of learning and human interaction are also essential in mobile learning interventions where learning experiences are triggered on the move by being situated in the continually unfolding contexts. Contextual mobile learning is not simply about the delivery of content, but about the augmentation of human activities in situated contexts. Hence, it is imperative to examine how contextual mobile learning can be supported by various learning scenarios, how mobile technologies or devices are being used and how contexts for learning are artfully created through continual interactions among people, technology, and settings (Brown et al., 2010; Sharples et al., 2009). A cycle displayed in Figure 2 below is to visualize all those factors at the three levels under the sphere of contextual mobile learning.



In this dynamic cycle, all three levels are integrated. We visualize them separately as three levels for analysis, but they should not be treated as fragmented

Figure 2 Integration of three-level factors

Limitations, Future Research and Challenges

This paper suggests that, while there are some challenges, the future of mobile learning in the new era is promising when all three levels in the proposed framework are well integrated into the design, enactment and evaluation process. Although the three-level evaluation framework is applied to the systematic review of 28 papers about contextual mobile learning, it leaves open whether there are some other prominent factors that should be considered in or out of all three levels. Our understanding of the root value of education is often limited by the prevailing paradigm of learning, and we should look closely beyond superficial effects of novel modes of learning. Although mobile and social technologies are deployed to blur the boundaries between the real and the virtual space and between the open and the closed learning environment, the main barriers to transform learning are not technical but social. Because macro-level factors at societal and cultural levels are intangible and are seldom discussed in detail in empirical studies, currently the evaluation of contextual mobile learning at the external level is core but lack of evidence.

The evaluation of how and to what extent different learning styles and different levels of context awareness influence learning outcomes are not covered in this study. Additionally, this paper does not discuss ethical implications and differentiations in the three levels of different subjects and different education levels. Last but not least, our limited understanding of mobile learning environments, the range of learning abilities and learning preferences among different people are the obstacles and challenges for an evaluation of learning in a contextual mobile learning context.

CONCLUSIONS

The three-level framework developed in this paper provides one possible way for evaluating contextual mobile learning with the introspective method on the whole. At the external level, when socio-cultural conditions are conductive to the mobile learning approaches and when knowledge sharing culture emerges naturally, we can make effective use of the advanced mobile technology for situated and contextual learning. At the inter-medium level, a good design should infuse well-structured facilitations, interesting activities and proper mobile learning platforms/devices. At the internal level, the learning approach and the whole design should not only enhance leaning motivation, but also improve the cognitive achievements of the learners. The proposed framework provides a systematic structure in evaluating mobile learning strategies at the organizational level, in designing mobile learning activities at the educational level and in studying learners‟ experiences and attitude at the users‟ level. From a broader point of view, continuous reflective evaluation with the proposed framework would give researchers and practitioners insights into the design, implementation, and evaluation of contextual mobile learning.

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Tablets with Restricted Mobility: Investigating User Acceptance in a South African Mathematics Mobile Learning Project

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ABSTRACT

Ericsson initiated a project called „Connect to Learn" (C2L), where a mobile learning solution focused on introducing creativity and interactivity into the classrooms of South Africa using various mobile technologies and applications, was developed. Ericsson has employed this solution in various schools in and around Johannesburg, South Africa. This research study focuses on investigating the user acceptance (teachers and learners) of utilizing tablets (MobiPads) in the learning of mathematics in classrooms participating in the C2L project. The tablets are not owned by the learners and are not used by learners in an informal environment outside of school boundaries. The tablets therefore have restricted mobility and the study contributes by exploring user acceptance of semi-mobile learning. It is shown that learners value the mobility feature of the devices, even though it is limited. However, what proves to be essential for acceptance of mobile mathematics learning is the content, its relevance to real-life situations, providing capability to explore and the mapping of the content to the curriculum.

Keywords

mobile learning, Android mobile tablets, MobiPad, user acceptance, mathematics education, mathematics mobile learning, restricted mobility.

INTRODUCTION

We are living in a new era of technology enabled personal mobility, which inevitably affects our education systems and offer the opportunities to design teaching and learning differently. Outside of schools, information and communication technologies (ICT) such as mobile devices are changing the way students find information, how they learn and even how they are entertained. This resulted in a new era of learning and teaching being realized that moves away from the static classroom structure of "chalk and talk, as well as desk and texts" (Roschelle, Pea, Hoadley, Gordin & Means, 2000, p.76) and moves towards dynamic learner-centric environments that facilitate more personalized, contextualised and collaborative learning (Liu, Han & Li, 2010).

In Africa, when comparing the amount of users of fixed lines with users of mobile phones, Lange (2010) reports that in early 2010 mobile users constituted more than 90% of all African telephone subscribers. This fact together with the apparent ease with which South Africans adopt mobile technology suggests a wide range of possibilities for development in South Africa using mobile technology, including mobile learning.

Education in South Africa faces many challenges of which inadequately trained teachers is but one (Matthee and Liebenberg. 2007, p.156). This results in poor performance in science and maths, those subjects on which a budding economy depends. In the 2003 TIMSS (Trends in International Maths and Science Study) tests South Africa had come last, even behind African countries such as Ghana and other developing nations whose expenditure on education is far less than that of South Africa (Mail and Guardian, 2010). South Africa pulled out from the 2007 TIMSS test.

Given these challenges, the government as well as private companies are trying to address the problems facing education, and specifically mathematics and science education, in South Africa. The case reported in this paper is part of such an initiative where Ericsson together with other partners started a mobile learning project, the so called Connect to Learn project. The next section gives more detail on the project.

CONNECT TO LEARN PROJECT

In September 2010 Ericsson launched the Connect to Learn (C2L) project with the goal to "implement ICT to connect classrooms and improve access to quality educational resources for learners and teachers around the world, even those in the most remote villages" (http://www.connecttolearn.org/). Ericsson has employed this solution in various schools in and around Johannesburg, South Africa of which the school discussed here forms a part.

IT School Innovation is a partner of Ericsson and the C2L project. IT School Innovation, an ICT education company (http://itschools.co.za), is the creator of the MOBI® project and develops products that are integrated, accredited and curriculum based. IT Schools Innovation has designed the educational applications that are found on the MobiPads such as MobiMaths. The MobiPad was introduced in 2010 by the MOBI® project. The MobiPad is a tablet mobile device with a 7 inch touch screen. It comes with a pouch with a full QWERTY keyboard (see figure 10) and runs on a Google Android platform. The MobiPad contains, among other, pre-installed MobiMaths software, which is the core feature of the MobiPad (http://www.phusionmedia.com/MobiPad/). MobiMaths is based on the South African mathematics curriculum of Grade 4 to 12 and allows the user to complete theory examples, exercises and assessments relevant to their grade. In addition, the MobiPad is supplemented with more than 3000 tutorial videos that the user can access by the press of a button. The MobiPad also contains pre-installed MobiParent software that parents can use to monitor their children‟s‟ progress in completing content on the MobiPad. Other mobile learning technology that was used to supplement the MobiPads were laptops (for teachers), projectors and screens, docking trolleys to charge the MobiPads in and interactive whiteboards. Distance learning technology included a Samsung Scopia VC220 video conferencing system.

RESEARCH OBJECTIVE

Although one of the distinctive characteristics of mobile learning is mobility (learning anywhere/anytime), mobile technologies in this project have restricted mobility. Learners do not own the technology and cannot take it home. More detail will be given on the background in the "method" section. Given the increasing interest of educational institutes to employ mobile learning, it becomes crucial to gain more understanding of the factors that influence students‟ satisfaction and acceptance of mobile learning (Wang, Wu & Wang, 2009; Hassanein, Head & Wang, 2010), since the acceptance of mobile technologies by itself does not guarantee the acceptance of mobile learning (Liu, Han & Li., 2010). According to Liu, Han and Li (2010), research on user acceptance of mobile learning is still in short supply. From an academic perspective it becomes interesting to investigate user acceptance of mobile learning where mobility is limited. . From a practitioner‟s perspective it is also important to investigate user acceptance of mobile learning in this project to enable better practice in future.

This research therefore investigates user acceptance of mobile mathematics learning where learning with the devices takes place only in a face-to-face classroom environment, i.e. the mobile device are not used by learners in an informal environment outside of school boundaries; the learners do not have ownership over the mobile learning device; and learning takes place in a developing context, namely South Africa.

RESEARCH APPROACH

This research uses a case study strategy from an interpretivist view. Interpretivism is concerned with "understanding the social context of an information system" (Oates, 2006, p. 292). All processes concerning teaching and learning with tablets occur in social settings and thus research subjects, both teachers and learners, should be studied in their natural classroom settings and not in a laboratory or other measured or controlled environments. The research on which this paper is based, investigated two different case studies: one grade ten mathematics class from a high school and one grade seven class from a primary school. Only the first case study will be discussed in this paper. Interviews were used as the data collection method for this case study. An individual interview was conducted with one mathematics teacher and two group interviews with the learners. Interviews conducted with the teacher and learners were semi-structured, which allowed the interviewees more freedom to „"speak their minds" (Oates, 2006, p. 188). The interviews were aimed at eliciting the participants‟ thoughts around the use of tablets in mathematics and how the tablet may have contributed to their knowledge and understanding of mathematics.

The questions of the interviews and questionnaire were structured around the elements of the proposed theoretical framework given in the next section. Once the data have been collected as explained above, it was transformed into a standard format. The researchers then identified key themes from it, aligned to the theoretical framework.

Case study

The participating public school is located in Johannesburg, South Africa. They use MobiPad to facilitate mathematics learning in grade ten both during school hours and during extra mathematics classes outside of school hours. Currently, only the grade ten mathematics learners participate in the Ericsson C2L project. The project was introduced to the school by selecting 18 learners to receive formal training. Their training included basic IT training, MobiPad training (thus training on how to operate the tablet device), training on how to use the interactive whiteboard equipment and also training on understanding the content of the device (the applications). Thereafter, it was expected from the trained learners to take the role of the trainer and transfer all the necessary skills that they have learned to their untrained learners.

The Ericsson C2L project also enabled the school to take part in distance learning via live broadcasting to various other high schools. When a Grade 10 mathematics lesson is given by an educator at another high school, the learners at the school view the lesson material on an interactive whiteboard in the their classroom. The learners are then able to answer questions in real-time on the whiteboard and feedback is given to the educator from the other school that is presenting the mathematics lesson.

The school is only utilizing the MobiPads in class for mathematics modules that learners tend to struggle with. The structure of a mathematics lesson where the MobiPads are used is as follows: the teacher presents a short lecture on the maths content in a traditional manner, after which the learners do exercises on the MobiPad and the teacher moves into the role of a facilitator. The MobiPads are handed out in each class and are collected again at the end of the class. It is the responsibility of the teacher to look after the devices, which includes keeping it in storage and charging the devices..

Figure 1: Learner at the school while interacting with the MobiPad

A MOBILE LEARNING ACCEPTANCE THEORETICAL FRAMEWORK

For the purpose of this study, „acceptance‟, „adoption‟ and „satisfaction‟ will be used as synonyms. This is based on the fact that various researchers in the literature used it as such (Liu, Han & Li., 2010; Crescente & Lee, 2011). The objective of the study was to investigate students‟ and teachers‟ acceptance of the use of tablets in classrooms as a tool for learning mathematics. The researchers combined the following models to compose a composite theoretical framework that the researchers believe is a better fit to be utilized for evaluating m-learning acceptance in this context: Unitified Theory of Acceptance of Use of Technology (UTAUT) (Venkatesh, Morris, Davis and Daivs, 2003), an extended UTAUT model for learning with tablet PCs (El-Gayar and Moran, 2006), TAM (Davis, Bagozzi & Warshaw, 1989), an extended TAM model for m-learning (Huang, Lin & Chuang, 2007) and a two conceptual m-learning acceptance models suggested by Liu, Han and Li (2010) and Hassanein, Head and Wang (2010). Figure 2 depicts the composite theoretical framework and all the included constructs.

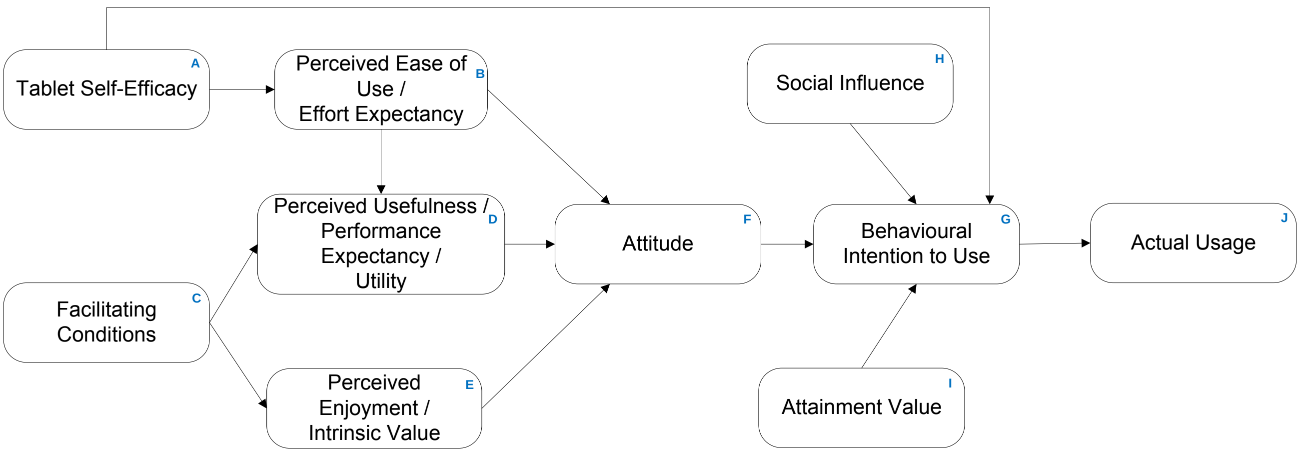

Figure 2: Composite Mobile Learning Theoretical Framework

While studying students‟ intention to use web-based learning, Chiu and Wang (2008) suggested an extended UTAUT model where self-efficacy was modeled as having a direct effect on effort expectancy and also suggests that self-efficacy affects intention to use the technology. While studying students‟ acceptance of tablet PC computers, El-Gayar and Moran (2006) and Moran (2006) suggested an extended UTAUT to include self-efficacy as affecting intent to use or behaviour intent. Tablet self-efficacy represents a person‟s perception of their capabilities to use the tablet to complete necessary m-learning tasks. Effort expectancy is defined as "the degree of ease associated with the use of the system" (Venkatesh *et al.*, 2003, p. 450). Perceived ease of use can be defined as the perception of the user that using the technology will not require a lot of effort (Huang, Lin & Chuang, 2007). Consequently, based on the latter two definitions, it can be said that the *effort expectancy* construct of UTAUT relates to *perceived ease of use* of TAM which refers to the student‟s perception of how much effort will be required to use the tablet for m-learning. The different relationships between the constructs in Figure 2 will be explained below.

A → B and A → G: if a student believes that they are capable of using the tablet for m-learning, they will perceive it as easier to use and similarly, they will also be more likely to intend to use the tablet.

B →D: In TAM, Davis (1986) modelled perceived ease of use (similar to effort expectancy as previously mentioned) to have a direct influence on perceived usefulness. Perceived usefulness can be described as the degree to which the user believes that the use of the technology will enhance or positively affect their performance (Huang, Lin & Chuang, 2007). Venkatesh et al. (2003, p.447) defines performance expectancy as "the degree to which an individual believes that using the system will help him or her to attain gain in job performance". Utility value refers to how the learner sees m-learning as valuable in contributing to their short term and long term goals (Liu, Han & Li, 2010). Consequently, based on the latter three definitions, it can be said that *perceived usefulness* from TAM is related to *performance expectancy* from UTAUT, and also to *utility* extracted from the conceptual model suggested by Liu, Han and Li (2010). The relationship between perceive ease of use/effort expectancy and perceived usefulness/performance expectancy/utility can be understood with an example where increasing ease of use of a technology would cause an increase in the performance level that is expected, or otherwise stated, if a technology or application is easier to use, meaning it requires less effort to operate, it will be perceived as more useful and a learner might see m-learning as valuable in contributing to their future goals (utility).

C → D and C → E: When constructing a conceptual model using literature from IS and also from education and psychology to evaluate user satisfaction of m-learning, Hassanein, Head and Wang, (2010) showed that *facilitating conditions* (a construct extracted from UTAUT) have an effect on both *perceived usefulness* similar to performance expectancy and utility as stated before) as well as *enjoyment*. According to Liu, Han and Li (2010) *intrinsic value* is associated with enjoyment, as it refers to how much a learner views m-learning as enjoyable by itself. Facilitating conditions can be seen as any resources, support structures and other factors in place to assist students in using the tablets. According to Hassanein, Head and Wang, (2010, p. 291), "facilitating conditions imply circumstances that enhance the pleasure associated with using the information system". In the context of this study, this refers to the circumstances that increase the enjoyment associated with using tablets for learning.

B → F, D → F and E →F: According to TAM developed by Davis (1986), *attitude* towards the technology is directly affected by *perceived ease of use* (similar to *effort expectancy* as previously mentioned) and *perceived usefulness* (similar to performance expectancy and utility as stated before). If a learner does not perceive the tablet as easy to use and/or useful, they are likely to have a negative attitude towards using the tablets for learning. Huang, Lin and Chuang (2007) applied an extended TAM to an environment where their goal was to explain and predict user acceptance of m-learning and found that perceived usefulness and perceived ease of use are critical in determining students‟ attitudes towards m-learning. As previously mentioned, Hassanein, Head and Wang (2010) included *enjoyment* as a construct to evaluate user satisfaction of m-learning. Huang, Lin and Chuang (2007) also included *perceived enjoyment* and suggested that it affects attitude toward m-learning and described it as a "causal relationship" (Huang, Lin & Chuang, 2007, p. 589). If users perceive using tablets for learning as enjoyable, it positively affects their attitude towards learning with tablets.

F → G: Several models, including TAM and other conceptual models in the literature include *attitude* towards using m-learning as one of the constructs used to evaluate acceptance of m-learning (Davis, 1986; Chiu & Wang, 2008; El-Gayar & Moran, 2006; Moran, 2006; Huang, Lin & Chuang, 2007; Hassanein, Head & Wang, 2010). All of the above mentioned models suggested prove that there is a relationship between attitude and *behavioural intention to use* the relevant technology. El-Gayar and Moran (2006) even found *attitude* to be the strongest predictor of user acceptance of tablet PCs. *Behavioural intention to use* is where the student decides whether or not they want to use the tablet for learning. If a student has a negative attitude towards m-learning or tablets, they are unlikely to intend to engage in m-learning activities on tablets.

I → G: *Attainment value* refers to the "personal importance of doing well on a task" (Chiu & Wang, 2008, p. 195) with regards to personal values, achievement goals, etc. Chiu and Wang (2008) suggest that *behavioural intention to use* the technology is also effected by *attainment value*. If a student values it to do well in learning on a tablet, they are more likely to intend taking part in m-learning activities on tablets. In the context of this study, mathematical content are provided on the tablets, so if a student values it to do well in mathematics, they will probably engage in m-learning mathematics activities on tablets.

H →G: *Social influence* refers to the degree to which students care about how others will view them after they have used the tablet for learning. This construct is included in UTAUT and modeled to have a direct effect on *behavioural intention*. Moran (2006) and El-Gayar and Moran (2006) also included *social influences* in their extended UTAUT model as a construct to evaluate user‟s acceptance of tablet PC technologies and as having an influence on behavioural intention. If a student perceives that using the tablets for learning might make them, for example, seem smarter to his fellow students, it will likely positively influence their behavioural intention to use the tablet PCs for learning.

G → J: *Actual usage* is included in TAM as actual system usage and in UTAUT as use behaviour. Moran (2006) and El-Gayar and Moran (2006) also included use behaviour in an extended UTAUT model for the purpose of predicting user acceptance of tablet PCs. In all above mentioned models the actual usage of the system is directly affected by *behavioural intention to use*. Thus, if students do not intend to use the tablets as a m-learning tool for practicing mathematics, they will not actually use the tablets.

Due to the fear of damage or loss of the tablet devices, the students were not allowed to take the devices home with them. Thus, the devices were used only in the classroom environment and students did not really get to experience the mobility feature of these tablets. Therefore, the *perceived mobility value* construct from the model suggested by Huang, Lin and Chuang, (2007), was excluded from this theoretical framework.

FINDINGS

In this section the data gathered through the above mentioned interviews are analysed at the hand of the proposed theoretical framework developed by the researchers in the section above. In numerous instances the perspectives of the learners correlated with those of the teacher but in some instances it differed radically.

Tablet Self-Efficacy

Tablet self-efficacy represents the teachers‟ perception of their capabilities to use the tablet to complete necessary mobile learning tasks. Responses to the concept of self-efficacy differed between learners and teacher. Although the learners had no prior knowledge of tablets, or MobiPads, the majority of the learners had confidence in their technology skills and capabilities to use the tablets or confidence in their capability to easily pick up on any skills that they lack. Furthermore, the learners had complete confidence in their technical skills and knowledge that they learned through formal training to properly transfer the knowledge and skills to their fellow classmates. After being introduced to the MobiPad, and seeing that it is easy to use, those learners that questioned their self-efficacy, felt re-assured that they had the necessary technology skills to use the MobiPad. One learner stated that "we didn‟t need to learn new technology skills, because it was not hard to use the MobiPad, it was basic steps".

On the other hand, the teacher responded by saying "it was a new technology that I was not familiar with". He felt that he surely needed training to familiarize himself with the new device. However, the teacher was confident that he will be able to quickly learn the required technology skills once he receives training. It is important to note that the interviewed teacher was of a young age, which partly explains his tablet self-efficacy.

The teacher and some learners who did not have high initial tablet self-efficacy before receiving training, stated that after being trained, they had also then acquired confidence in their capabilities to use the MobiPads to learn mathematics. This suggests a relationship between facilitating conditions (training is a facilitating condition as explained before) and tablet self-efficacy.

Perceived Ease of Use / Effort Expectancy

Both learners and teacher found the tablet device as well as the applications on the device easy to use. The teacher explained that "after introducing the devices into the mathematics class, all the learners in the class knew how to use the device after only two days". Some compared the device to a laptop and said it is even easier to use and easier to carry. When learners got stuck on a specific sum or mathematical problem, the device provided them with several help functions that gave further explanation.

When asked to comment on the technical features of the MobiPad, the teacher and learners did not have much criticism. The minority of the learners found the small screen size sometimes limiting when a mathematical sum stretches across two pages, but also added that it happens rarely and is not a big concern. The majority of the learners were not bothered by the screen size and added that "no extensive scrolling is needed to read the exercises". The satisfaction of the learners with the technical features of the MobiPad can be attributed to the fact that the applications and learning content of the device were designed with the relevant mobile device in mind, for instance the size of the screen. Furthermore, the device itself were designed for educational use.

The extra keyboard served as an extra option that the teacher and learners can use to input data but some learners commented by saying that "the touch screen was actually enough because we only had to answer multiple choice questions". As previously mentioned, it is the responsibility of the teacher to charge the battery of the MobiPads and this can pose to be a challenge. The docking trolley proved to be ideal for this purpose. The teacher commented saying "this makes it very easy for me to charge the devices and I also know that it is safe inside the trolley". He also expressed that he thinks the device has a good battery life as it generally lasts a week.

Perceived Usefulness / Performance Expectancy / Utility

Through the data gathered in the interviews, it is apparent that the teacher and learners perceive the use of the MobiPads in mathematics learning as very useful. Both teacher and learners identified opportunities that the tablet offers them that they did not previously have. The learners recognised that the worth of the tablets providing them with extra maths practice and explanation, in addition to those provided by their teacher. They describe the tablet as a "very successful and helpful thing" that extends their usual method of learning maths with a lot more exercises. Occasionally the MobiPads technologies were used in distance learning where they were given a mathematics class by another maths teacher from another school. Although the learners view the MobiPad as valuable in contributing to their knowledge, they have however not yet associated the use of the MobiPad with improved mathematics grades. When asked the question of whether their grades improved due to the use of the MobiPads, the following response was the norm: "No, we did not actually use the MobiPad that much". Although the learners did state that, for those chapters that they did use the MobiPad, they understood the maths better. Nevertheless, when looking at the big picture, they do not yet feel that their grades improved due to the MobiPad.

As identified in the literature, mathematics is generally a „problem‟ subject that learners underachieve in, struggle to understand and have little interest in. Several researchers have asked themselves the question of how can mobile learning be useful in teaching and learning mathematics. (Tangney *et al.*, 2010; Swan, van „t Hooft & Kratcoski, 2005). Tangney *et al.* (2010) theorizes that three things need to occur to make mathematics education „closer to the learner‟: (a) getting rid of the didactic teaching methods; (b) allowing learners to explore various ways of finding solutions to problems; (c) and teaching maths on the context of real life situations and examples. The teacher and learners recognize how useful the tablets are in addressing all three of these factors. While lecturing to learners did not completely disappear from the classroom lessons, as in these case studies the teachers still spend some time at the beginning of the lesson explaining the content of the maths lesson, the majority of the time is spent as a facilitator to learners while they do mathematical exercises and further explanations on the tablets. This way, learners are also exposed to different methods and processes of finding solutions. Also, receiving lessons from external teachers via video conference just further expose them to knowledge and stimulation. One of the most valued aspects of the tablets expressed by the teachers is how it provided for teaching mathematics in a contextualised manner by integrating abstract mathematical concepts with real life examples and situations.

Bringing technology devices into the classrooms can potentially be more of a distraction as the learners can use these devices for other purposes than that it was intended for as the learners have access to the internet through the MobiPad. During the interview, the teacher expressed that he realises this and therefore enforces a lot of discipline and is very strict with the learners on using the device only for mathematics learning purposes.

Facilitating Conditions

Facilitating conditions are those conditions that the user believes to exist in support of using the technology (Venkatesh *et al.*, 2003), such as training, technical support, instructor or peer support and any additional resources. The interviewed teacher explained that, before starting to facilitate classes to learners, he received extensive training on how to operate the device, as well as how to deal with various problems and situations that he might come across. The teacher in this study is the only teacher at his school involved in the C2L project, thus he does not have peer support at the school but stated that "there is a lot of people I can phone when I have any problems with regards to the MobiPads that I do not know how to handle" but then again pointed out "but they trained me very well to deal with all sorts of issues, so it happens rarely". This covers the technology support that the literature points out as often overlooked when introducing technology into classrooms.

As previously explained, 18 of the learners who are currently involved in the C2L project have received formal training for a duration of 2 weeks. Thereafter, those learners trained their peers by transferring those skills and knowledge that they acquired at the formal training sessions. A learner pointed out that "we appreciated the training, because we want to be careful with the device and look after it well, so after training we knew exactly what to do with it and how to work with it and therefore could enjoy it more from the moment we started doing maths on the device". When asked to explain what support systems exist in terms of using the MobiPads, the interviewed learners explained that they have complete confidence in their teacher‟s ability to provide them with technical support as well as help them with any issues relating to the MobiPad and the mathematical content. One learner further mentioned that "we also help each other with any issues relating to MobiPad as a device, since the majority of us also received formal training". This confirms a relationship between facilitating conditions and perceived enjoyment as modelled in the theoretical framework of this study.

Another factor pointed out in the literature that can „make-or-break‟ an mobile learning project is the manner in which the mobile devices are integrated into the curricula. This needs to be done in a suitable way so that the learners find it usable and attractive, while still making pedagogical sense. The teacher described in the interview that he works in conjunction with the people who created the Mobi project to design, develop and structure lesson plans to integrate the MobiPads in a suitable way into the mathematics curricula. This confirms a relationship between facilitating conditions and perceived usefulness as proposed in the proposed theoretical framework of this study.

Perceived Enjoyment / Intrinsic Value

As stated in the literature, intrinsic value is associated with enjoyment, as it refers to how much a learner views mobile learning as enjoyable by itself (Liu, Han & Li, 2010). Learners expressed that they thoroughly enjoy learning mathematics with the MobiPad. One learner stated that “the MobiPad makes maths fun and interesting”. The teacher confirms this by stating that “I can definitely see that the learners enjoy learning with the MobiPad and that makes it also enjoyable for me to facilitate the classes with the MobiPads”.

Attitude

The teacher valued the tablets as an extra tool in supporting them as teachers in terms of providing learners with mathematics practice. One of the aspects of the MobiPad that the teacher valued the most was how the exercises on the MobiPad connected mathematical concepts to real-life situations and thus allowed the learners to see and realize how they can and will use maths in the outside world. He continued by saying that “this naturally created more positive attitudes towards mathematics as a subject.” The learners repeatedly expressed how glad they are to be moving away from the boring „chalk and talk‟ classroom structure where they have to write down everything from a board that is explained by their teacher and how much they *enjoyed* using the MobiPad instead. Throughout the interview, learners expressed how *easy* the MobiPad is *to use* as one learner stated that “if we don‟t understand something, there is a button we can press on the MobiPad and then we receive a step-by-step explanation of how to solve the problem”. Features like repeat, explain, pause, etc. on the applications on the MobiPad makes the learners feel that they have total control over their maths learning.

Social Influence

Social influence refers to the degree to which learners care about how others will view them after they have used the tablet for learning. Some learners view the use of the MobiPads as some sort of a status symbol when one learner replies that “it does make us feel cooler because we are the only class in the school who is using the MobiPads”. However the majority of the learners indicated that their family does not even know about the C2L project and that they do not associate the MobiPad with status. Social influences seem to play a bigger role for the teacher. The teacher explained that since the start of the project, the other teachers have shown more interest in speaking to him. In some instances, their interest displayed jealousy towards him being part of the Ericsson Connect to Learn project, and in other instances their interest displayed respect towards him having knowledge about this new type of technology. Some teachers have even requested the interviewed teacher to train them on using the MobiPad.

DISCUSSION

As explained elsewhere, the researchers decided to exclude the construct *perceived mobility value* from the proposed theoretical framework. The reason for this was the limited mobility of tablets in the context of the case study. *Perceived mobility value* refers to how much value an individual places on the mobility feature of mobile learning (Huang & Lin, 2007). In a sense, the restricted mobility of the MobiPads in the classroom makes it comparable to a computer lab with maths educational software. Do these tablets have any mobility features valued by the users? It emerged from the interviews that learners compared the MobiPads to laptops and spoke about how easy it is to carry – implying mobility within the classroom. That is, learners are not stuck to a PC station but can move between peers with their tablets while learning and collaborating. Also, safekeeping of the devices is easier than that of a computer lab since the devices can be locked in the docking trolley and put away in the school‟ safe at the end of a school day. It seems that the mobility of the tablets, albeit restricted, still positively influences user acceptance of mobile learning. The teacher pointed out that he would have preferred full mobility of the tablet devices such that learners could take it home with them to further exercise mathematics outside of school boundaries. It is suggested that the full mobility characteristic of the tablet device would have had an even greater effect on the acceptance of learning mathematics with a tablet.

CONCLUSIONS

This paper investigates user acceptance of mobile mathematics learning in a context where the mobile devices has limited mobility and where the learning environment is situated in a developing context. It seems that learners valued the mobility feature of the devices, even though it was limited. The value of mobility in a classroom or group setting as well as the easy safekeeping of the devices was highlighted as factors contributing to acceptance. The teacher pointed out that full mobility would have influenced acceptance even more.

This study was undertaken by a fourth year student in Information Systems with research focus user acceptance of mobile learning. The fact that the content was mathematics was not considered as important. However, what became clear in this study was that the mobile device is a necessary but not sufficient condition for successful acceptance of mobile mathematics learning. Instead, the content, its relevance to real-life situations, providing capability to explore and the mapping of the content to the curriculum prove to be essential. What these results imply is that current acceptance theories (e.g. TAM) do not provide enough explanatory or predictive power for subject specific mobile learning acceptance studies. The model proposed by Liu, Han and Li (2010) should be of more value since it classifies the mobile learning user as technology user, consumer and learner. Under the category learner, the construct *subjective task value* might be of value in explaining the importance of the mathematics content and software in successful acceptance.

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The use of mobile technologies to overcome digital inequities in prison education: a pilot project

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ABSTRACT

Incarcerated students face a number of additional challenges to those faced by most other students studying at a distance. Lack of internet access is especially problematic for those studying in a sector that is increasingly characterised by online and flexible course offerings. In this paper, we report on a project that will attempt to address the digital challenges that hinder prisoner access to higher education and provide inclusive learning experiences for incarcerated students. The trial utilises mobile yet secure digital technologies – namely Stand-Alone Moodle (SAM) and e-book readers – to improve access to resources. It is being trialled with a small sample of incarcerated students participating in the *Studying to Succeed* course within the Tertiary Preparation Program (TPP) at the University of Southern Queensland (USQ). We discuss the current provision of higher education in prisons and the challenges resulting from increased reliance on mobile learning technologies in higher education generally. The potential of the trial project to address the digital divide experienced by incarcerated students as compared to the general student population will also be discussed. It is hoped that students will be participating in learning experiences more closely related to those experienced by students outside of the prison system and they will be acquiring e-literacy and e-research skills. In addition, USQ will be fulfilling its obligation in relation to equity of access; and will be addressing the Australian Government's agenda of increasing participation in higher education by socially and economically disadvantaged groups.

Author Keywords

digital inclusion; distance learning; higher education; prisons; Moodle; e-book readers, m-learning

INTRODUCTION

Australia's prison population averaged 29,106 adult prisoners in 2011 (ABS, 2011). Though imprisonment rates have fallen for the first time in a decade, the percentage of incarcerated offenders is still high, with a national imprisonment rate of 167 prisoners per 100,000 adults. The majority of prisoners are from low socio-economic status (SES) backgrounds and are more likely to face social and economic disadvantage. Many offenders have limited skills and an average education level of year 10 or below. As a result, they experience a greater chance of unemployment on release, face on-going health and social problems, and have limited work experience (Giles, Le, Allan, Lees, Larsen & Bennett, 2004). Each of these factors contributes significantly to recidivism. Though early research was inconclusive, most contemporary literature demonstrates that the rates of recidivism are significantly lower for prisoners undertaking a post-secondary educational program while incarcerated, as compared to the general prison population (Richards et al., 2008; Aceves et al., 2011). This is in part due to increased employment success upon release as a consequence of completing a post-secondary qualification (Batiuk et al., 1997). Distance education has traditionally been viewed as a boon to education in prisons, delivering education and resources to students that are unable to undertake traditional face-to-face education (Salane, 2008).

However, the increasing reliance of distance learning institutions on e-learning including the use of m-learning, virtual learning environments (VLEs), interactive online activities and online course delivery has resulted in greater challenges for incarcerated students attempting to participate in higher education. Access to mobile technologies within prisons for prisoner learning is severely restricted due to a range of security concerns and resultant policies. Almost universally, prisoners are not permitted access to the internet or to the mobile devices that potentially can access it such as mobile or smart phones, iPads, iPods, e-book readers or tablet computers. Beyond the perceived risks associated with the ability to access the internet, these devices pose other security risks such as batteries being adapted for use with bespoke tattoo guns, storage capacity being used for banned materials such as games or pornography, or charging cords being used as weapons. Learning initiatives utilising ICTs often pose an unacceptable security risk and consequently, there is very little literature about the use of technology, particularly mobile technologies, in correctional facilities (Rozalski, 2005).

This paper describes the design and development of a pilot project, PLEIADES (Portable Learning Environments for Incarcerated Distance Education Students), designed and developed by the University of Southern Queensland to address some of the barriers to participation in higher education by incarcerated students. The aim of the project is to trial the use of e-learning technologies, including mobile technologies, which are independent of the internet, yet still enable students to access USQ courses electronically. These technologies are initially to be used in prisons but could be adapted for other learning environments in which students cannot readily access the internet; such environments might include regional, rural and remote areas in Australia. The learning technologies to be piloted include an internet-independent version of USQ's Virtual Learning Environment (VLE) specifically developed for the project, called Stand-Alone Moodle or SAM. SAM will replicate USQ's online learning environment for incarcerated students enrolled in the Tertiary Preparation Program. It will enable students to view and use the same course materials, learning activities and assessments embedded in the USQ VLE but in a simulated online environment without having any possibility of gaining access to the internet. The use of SAM in PLEIADES will also be supported by the use of e-book readers. The e-book readers chosen for this project have no wireless or 3G connectivity capabilities but will enable students to access course and reference materials in order to extend learning beyond the computer lab and into personal and leisure time (for example, after routine daily lock-down). In this way, an equivalent learning experience will be provided for incarcerated students as compared to non-incarcerated students at studying the same programme at USQ. The project will be deployed in Semester 2 2012 (July to November) with a maximum cohort of fifteen incarcerated students enrolled in course TPP7120 *Studying to Succeed* as part of the Tertiary Preparation Program at the Southern Queensland Correctional Centre (SQCC). SQCC is located about an hour's drive from the Toowoomba campus of the University of Southern Queensland. It is a high-security, all-male prison with some 300 beds. It is Queensland's newest prison and will be one of a number of prisons located in the 680 hectare Southern Queensland Correctional Precinct to be operated by Serco Australia Pty Ltd (Department of Community Safety, 2012).

CURRENT PROVISION OF TERTIARY EDUCATION IN PRISONS

One of the roles of prisons is to provide an effective environment that reduces the risk of reoffending. Changes in the corrective services sector in Australia over the past decade has resulted in an increase in the adoption of 'thoroughcare' strategies. These involve the provision of programmes and opportunities to offenders that address the cause of offending, reduce the risk of re-offending and maximise successful re-integration into the community (Callan & Gardner, 2007). The role of education in prisons serves two purposes: increasing opportunities for employment after release, but also most importantly, improving self-esteem and self-confidence to assist in avoiding the negative lifestyle temptations that contributed to the initial incarceration of offenders (Callan & Gardner, 2007). As a result of this change in priorities, a greater emphasis has been placed on education opportunities for prisoners including programmes featuring career counselling, mentorships and career placement. Studies have found that these programs, particularly participation in formal education programmes, have generally been successful in reducing recidivism (Australian Institute of Criminology, 2008; Callan & Gardner, 2007). Even so, participation in education remains low with just 35% of eligible prisoners in 2009-10 participating in accredited education and training courses. The highest participation rate was in vocational education and training courses (27%), 6% participated in secondary school education, 3% in pre-certificate Level 1 courses and only 2% participated in higher education (SCRGSP, 2008). The decision to participate in formal education depends on a number of factors including the length of a prisoner's sentence, the constraints of sentence management plans, the capacity of education officers, the demands and flexibility of prison jobs and most importantly, the availability of programmes and courses (Giles et al., 2004). Interviews conducted with prisoners involved in vocational education and training (VET) programs indicate that education is viewed as broadly positive, resulting in great personal satisfaction, improved self-esteem and conducive to further study while in prison (Cox & Carlin, 1998). Overcrowding in prisons and restricted access to equipment, particularly computers and other technologies, further limits prisoner access to education (BearingPoint Review, 2003). Prisoners are hampered in their choice of programme by the extent to which component courses require students to access online learning activities.

Correctional centres across Australia are largely reliant on tertiary institutions for the provision of external studies or distance education for offenders who wish to participate in higher education (Dorman & Bull, 2003). Preparatory, undergraduate and some postgraduate programmes have traditionally been accessible to prisoners in print-based forms, sometimes supplemented by CDs (for use with in-cell laptops or in computer labs), audiotapes or videotapes (Dorman & Bull, 2003). These materials are sometimes supplemented by visits from tertiary teaching staff depending on the location of the tertiary provider in relation to the correctional centre. Due to procedural restrictions that prohibit prisoner access to the internet, prisoners in most Australian jurisdictions including Queensland, cannot access on-line or mobile learning. Formal education and training delivery to prisoners in these jurisdictions is currently provided in traditional, non-digital forms using large volumes of printed materials. This is becoming increasingly problematic given the increasing reliance on digital and mobile delivery of materials and assessment.

INFORMATION TECHNOLOGY AND LACK OF INTERNET ACCESS AS BARRIERS TO PRISON EDUCATION

Higher education institutions are increasingly incorporating e-learning, m-learning and other digital technology initiatives in order to remain competitive in modern knowledge-based economies. The education sector is depending on the inclusion of e-learning to expand and widen access to higher education and training for students; improve the quality of offerings and to reduce costs (Larsen & Vincent-Lancrin, 2005). The University of Southern Queensland is no exception. The 'Digital First' and 'USQ Connected' initiatives are both representative of the broader sector's increased reliance on online and mobile delivery. Though the increased use of technology in distance education does help address the emerging demand for mobility and flexibility in learning, at the same time it excludes significant portions of the student population including incarcerated students (Aceves et al., 2011). Because of this, incarcerated students have fewer options than ever before. Currently, supporting incarcerated students to successfully undertake university or other distance education studies, requires education officers at correctional centres to spend a great deal of time liaising with committed and sympathetic individuals in universities or other education or training providers, carry out the online research that students need to fulfil the demands of the course, and then print out that information for the students. As a consequence of these demands, the quality and provision of higher education initiatives to correctional centres is largely dependent on the goodwill and capacity of education officers and the correctional centres employing them. A major challenge for future distance education provision to this cohort is to identify alternatives that will allow prisoners to access learning management environments and electronic resources while maintaining the necessary security. Although the traditional forms of delivery using hard-copy 'blocks' of materials are successful to a certain extent, they do not enable incarcerated students to develop the technological skills and e-literacy skills that are essential to formal learning in current Australian education and training environments. Access to information and communication technologies within prisons for use in education is severely restricted. Most prison education centres provide access to computers which inmates may access for a limited number of hours under strict supervision and some prisons run in-cell laptop programmes for students engaged in tertiary studies (BearingPoint Review, 2003).

Incarcerated students are unable to access course materials and multimedia supplied via the course VLE (at USQ an instance of Moodle called the 'Study Desk') and they are unable to complete assessment online. Most significantly, they are unable to communicate with other students outside of the facility and even within the facility through course discussion boards. This undermines the social constructive pedagogy favoured in many post-secondary programmes (Erisman & Contardo, 2005; Bowden, 2002) and poorly prepares students for a world in which employers expect their employees to be familiar with social networking and other web 2.0 resources. The imperative to address this digital divide for these students is acute. How can correctional facility security be maintained while still providing incarcerated students with the benefits of learning with digital technologies? The PLEIADES project is an attempt to reconcile these competing needs.

ADDRESSING DIGITAL INEQUITIES USING SECURE LEARNING TECHNOLOGIES

Background to the project

The PLEIADES project resulted from discussions between staff at the Southern Queensland Correctional Centre (SQCC), Queensland Corrective Services (QCS), the Australian Digital Futures Institute (ADFI) and the Open Access College (OAC) the latter two both at USQ. The University of Southern Queensland is a dual mode institution that delivers both on-campus and distance education and has a high proportion of students from low socio-economic status (SES) backgrounds or from rural and geographically isolated areas. USQ has sought actively to support students in disadvantaged or vulnerable groups through the provision of a tertiary pathway beginning with a Tertiary Preparatory Program (TPP) articulating into various degree pathways. TPP is offered by the OAC to prospective students of the University of Southern Queensland over the age of 18 who cannot gain entry via the traditional pathways. If students complete the core components of the programme, they are awarded automatic entry to certain undergraduate programs at USQ (Orth & Robinson, 2010). Students enrolling in the TPP often have less developed academic skills than their undergraduate colleagues (Bedford, 2007) and require significant academic and social support to complete their courses successfully (Mehrotra et al., 2001). Typically, these students are from low SES backgrounds and may have experienced educational disadvantage (Klinger & Wache, 2009). If the TPP is to prepare students for university studies that incorporate the use of the online Study Desk and other digital resources, then developing e-literacy skills have to be an integral part of the course (Orth & Robinson, 2010). A significant number of incarcerated students from Queensland and other Australian states enrol in the TPP, and for this cohort in particular, these aims can be difficult to achieve. The course which is the focus of the PLEIADES project is TPP7120 *Studying to Succeed*.

TPP7120 *Studying to Succeed* is offered online and externally in semesters 1 (February to June), 2 (July to November) and 3 (December to February) every year. USQ uses the Moodle VLE to provide a Study Desk for each course. The Study Desk is an online resource that allows student access to lecturers, colleagues, related websites, quizzes, and many other useful resources. A Moodle template enables the Study Desk to display properly on mobile devices. It is a vehicle through which lecturers can keep students motivated as well as provide support and enrichment throughout the course (Orth and Robinson, 2010). Currently, an internet connection is required to access the Study Desk. Because incarcerated students have no access to the internet, they have not been able to access the Study Desk for this or for other courses. The project partners have discussed various ways to overcome this deficit for incarcerated students. To date, students have received large blocks of printed matter containing course materials and resources. This is costly for USQ to assemble, print and post, and is in no way interactive. Students enrolled in the same course have little contact with each other and certainly do not get to leverage the social support that is engendered by using the discussion boards on the course Study Desk site.

Stand-Alone Moodle

The project team determined that in order to provide an equivalent study experience for incarcerated students as compared to non-incarcerated students enrolled in *Studying to Succeed*, it would be necessary to somehow replicate the course Study Desk. This alternate instance of the Study Desk would necessarily need to be self-contained with no possible communication to the internet. It would have to be wholly contained on the Correctional Centre education server with installation and harvesting of results being conducted using flash drives by USQ's Division of ICT or SQCC education personnel. This instance of Moodle 2.2, which could be considered to be a 'satellite' instance of the main instance of the Study Desk was called SAM for Satellite Moodle, but eventually was renamed Stand-Alone Moodle in order to allay fears about security.

Within Australia, each state and territory has its own prison system. USQ has been working closely with Queensland Corrective Services to define the features and functionality of the Stand-Alone Moodle Study Desk that would comply with ICT and security constraints in that state. This modified VLE will be installed on the standalone educational server at the new Southern Queensland Correctional Centre to be located near the small town of Gatton and will be accessed via the network of computers available to students in a designated education lab located at the correctional centre. At designated times, incarcerated students will be able to access course materials including study modules, course readings and multi-media files, as well as complete quizzes and participate in discussion boards via the SAM VLE. The discussion boards will only be accessible to the incarcerated students while located in the correctional centre's education computer lab and under the direct supervision of the centre's education officers. These measures will be taken to ensure that discussion forums are used appropriately, bearing in mind that 'inappropriate use' could not possibly include internet use. It is expected that education officers will 'strip' the course assessment items prepared by students from the correctional centre instance of SAM and submit them directly into the USQ online assignment submission system. Education officers will have additional administrative rights to this system to streamline the process. In this way, incarcerated students will be able to gain many of the e-literacy skills they will need in their future studies and employment. They will be able to gain these skills in a simulated online environment without having or needing access to the internet, thus completely avoiding those security risks engendered by prisoner access to the internet.

e-Book Readers

Though the Stand-Alone Moodle system goes much of the way to fostering the e-literacy skills lacking incarcerated students, a lack of e-research skills in this cohort is still perceived to be a significant problem. Students within correctional centres, in common with many students outside of the corrections system, are often juggling part-time study with work commitments. In response to an increasingly diverse student cohort, USQ is exploring ways of delivering course content so that it can be consumed on a range of mobile devices. The intent is that content is created once and then delivered through multiple channels for consumption by the student according to his or her preference, device type and availability. These options for flexible and mobile delivery are not available to the student studying within a correctional centre. An incarcerated student undertaking a part-time study program may only have access to the relevant computer lab one afternoon a week if he or she is working full-time in addition to studying. There is an in-cell laptop computer borrowing scheme that some incarcerated students are able to access. Even so, the opportunities to extend learning beyond the correctional centre education lab are limited and laptops are not available to students enrolled in the TPP programme (these are reserved for students enrolled in degree programmes). In response to this need, the PLEIADES project team will pilot an e-book reader scheme to run in conjunction with the Stand-Alone Moodle trial. In this way, incarcerated students will have some experience of a mobile device, and have the opportunity to develop the e-literacy and e-research skills required in the contemporary workplace or in further study.

e-Book readers or e-readers are small portable electronic devices which can hold a large number of electronic files such as electronic books (e-books). The e-book readers in the trial will be loaded with course study materials and additional study resources of potential use to the students. The e-book readers selected for use in the trial are Sony PRS-505s, chosen because they do not have any ability to connect to the internet either via wireless or 3G networks. In addition they cannot connect remotely to another device other than through a specific cable which will be retained by the education officers. In fact, their lack of connectivity means that they are no longer manufactured. Should the pilot be scaled up, an alternative model of e-book reader would need to be found. Though there are a number of e-book readers that have no connectivity by default, nearly all have SD card slots which pose an unacceptable security risk as contraband materials could be loaded onto the e-book reader. In the future, SD card slots would need to be bound by security tape or otherwise plugged. Updates to the e-book reader will only be carried out when new course materials are released (approximately once a year) and this updating will be conducted by the education officers. The Sony ebook reader will not enable the incarcerated students to communicate with others or send or receive emails. It has a long battery life that can be measured in weeks or months depending on the level of use. The e-book reader batteries are an integral part of the device and cannot be removed or modified without damaging it. In addition the Sony e-book reader allows students to use a text-to-voice feature and it is anticipated that this feature will be useful for students with low levels of literacy.

The device supports a wide range of file types including Portable Document Format (PDF) and ePub (short for electronic publishing). The ePub format is integral to the PLEIADES project because it can support interactivity. Study-support resources such as self-marking quizzes and multimedia files (for example, lecturers' video-clips and Adobe Presenter presentations) can be embedded within the ePub files. Current course materials are stored on the Study Desk at PDF files. These are unsuitable for the e-book readers as viewing them requires the reader to scroll across the page for every line. The text does not reflow to accommodate the screen size making it a very tedious process to read a document. Before being converted into PDFs to be placed into the Study Desk, the course files are in Open Office format with a .odt file extension. In order to convert those original .odt files into ePub format, they must first be converted into .rtf files. Images are saved separately from the text and the text files are imported into the desktop publishing programme, in this case Pages on a Mac. The images are then reintegrated with the text and the files are exported as ePubs. A library is established in another programme called Calibre and the ePubs are imported and subsequently deployed onto the e-book readers.

For the pilot project, course materials and associated reference material will be vetted for copyright compliance and converted into ePub format for loading onto the Sony e-book readers to be provided to incarcerated students enrolled in the TPP7120 *Studying to Succeed* course. A migration from printed materials to digital resources could deliver benefits to correctional centres in addition to those afforded to incarcerated students. If correctional centres started replacing printed library books with e-books on e-book readers, for example, there would be fewer places for inmates to hide contraband, and more space freed up in prison libraries where space is frequently at a premium.

An e-book reader borrowing scheme will be set up by education officers at the Southern Queensland Correctional Centre, similar to the one that already operates to manage the borrowing of in-cell laptops. Each student borrowing an e-book reader will be required to enter into an agreement that transfers responsibility for the e-book reader to the student with penalties when the e-book readers are damaged. The e-book readers are charged using a cord that plugs into a USB port of a computer; in this case, an education officer's computer. Students using the devices will be able to hand their e-book readers to education officers on specified days for charging. The students will not have access to the cords used for charging the devices. They will be able to take the e-book readers back to their cells to browse readings, watch embedded multimedia, take notes on readings and thereby extend their study into their private time, outside of the correctional centre's computer lab.

EVALUATION

The pilot project will be deployed in July 2012 at the Southern Queensland Correctional Centre. An evaluation of the trial project will be carried out, involving the correctional centre education staff, the incarcerated students involved in the project, the course lecturers, and correctional staff responsible for IT security. Much of the research conducted in correctional centres fails to reflect the views of prisoners themselves (Richards et al., 2008). Consequently, ethical clearance has been obtained from USQ and the Department of Corrective Services so that quantitative and qualitative data can be collected from education officers, course lecturers and most importantly, from the students themselves.

CONCLUSION

In addition to incarcerated students, USQ delivers programmes to a large cohort of students from regional, remote or rural areas within Australia as well as internationally. These students are frequently from low socio-economic backgrounds where they also often experience difficulties in gaining access to the internet or using mobile devices. USQ and other distance education providers therefore need to address the issue of lack of internet access if they are to continue to remain viable providers of higher education within these environments. At present there are very few other prisons in Australia or globally that have successfully implemented electronic or mobile learning for incarcerated students.

At present, USQ expends large sums of money and resources on printing materials for students and providing individual alternatives to students who are unable to access online resources either from their desktop or mobile devices. USQ personnel are independently developing alternative approaches on a case by case basis without support from USQ policy or processes. The development and utilisation of secure learning technologies such as SAM and internet independent e-book readers for prison education will result in improved quality and consistency of educational initiatives, encourage student-centred learning and provide learning opportunities that can be tailored to a student cohort that have greater educational needs than the general community.

The project will be evaluated using a design-based evaluation methodology to determine whether these learning technologies are able to improve access, retention and completion rates of incarcerated students as well as give them an experience comparable to that of distance students who are not incarcerated. Results from the project outcomes will inform the University and wider stakeholders on innovative technological approaches to enhancing the digital inclusion of learners who cannot access the internet, and of the needs of students in areas where internet access is not possible such as in corrective facilities, remote Australian Indigenous communities, and other rural communities.

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Mobile 'SqueeView': Caring for the elderly with Mobile Learning

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ABSTRACT
As we are encountering to the aging society, the interest of serious games gets increasing. In this respect,'*SqueeView*' is aimed at enhancing visuo-spatial cognition of the elderly. In an empirical study with 35 mature adults, it was revealed that *SqueeView* had a significant effect for improving their visuo-spatial cognition capability. However, the SqueeView game that is based on the desktop computing environment is limited on time and space. We further address this issue with a new design concept on a mobile platform that can integrate game-based learning contents and computerized cognitive assessment.

AUTHOR KEYWORDS
Serious game, SqueeView, mobile learning, rehabilitation, cognitive assessment

INTRODUCTION
As the elderly are positioned themselves as the critical mass of the society's demographical structure, a lot of medical technologies in conjunction with new ICT (Information and Communication Technology) have been proposed (e.g., brain fitness program). Even mobile-based cognitive assessment has been introduced, such as CANTAB™ Mobile that detects the earliest signs of dementia. By this more effective and simple interventions can be made to prolong the patient's independence.

Indeed, the assessment-based application holds a strong position in effective patient identification and stratification to help target treatments more efficiently, but it would not be of great value for the elderly to enjoy optimal cognitive health and wellbeing throughout life. In this regard, serious games have been attractive, such as exertainment, that adds an entertainment factor to the well-known fitness programmes (e.g., Nintendo Wii Fit™ or Microsoft Xbox Your Shape™ Fitness Evolve). In conjunction with enhancing motor skills, rehabilitation program also focuses on boosting up their cognitive capability, and motivates the elderly to positively engage in it (Cameirão *et al.*, 2009).

However, most of the serious games now in the commercial market are accustomed to the desktop computing environment. It is partly due to technological limitations on the processing speed, display resolution, and a lack of input modalities. This makes people who use serious games much limited to time and space. At present, users should play games indoor such as rest homes, hospitals or rehabilitation centres, and occasionally need assistants to help them to perform those games correctly.

Perhaps, one of the main reasons why the game-based rehabilitation programmes are not quick to reach to the elderly or patients would be that they cannot assess the changes of their cognitive capability. Hence, relevant experts such as doctors or therapists are necessary to the adoption of the technology. On the other hand, the advent of mobile devices can make cross above and beyond the borders of the traditional gaming environment, with the help of their portability and constant accessibility, allowing users to access various facilities such as other smart devices or web pages while they are on the move. Moreover, they can provide information adapted to user's contexts such as time and space, and allow people to access information more efficiently and directly (Goodman *et al.*, 2004). Thus, combining these advantages of mobile technologies to serious games will make a synergy effect, but it is still elusive how to make this happen.

With this umbrella scope of the research goal, we take a first step to suggest a novel serious game for the elderly. In this article, we first present a brief overview of serious games in the rehabilitation area. Next introduces a new serious game called '*SqueeView*', which has been designed for prevention of dementia and its benefits for cognitive rehabilitation is demonstrated with an empirical study. Based on the findings, we finally propose a new design concept, and how mobile learning can be inserted into the arena of the serious game.

SERIOUS GAMES IN PREVENTION AND REHABILITATION
Several serious games for a clinical purpose have recently been highlighted as a new way of rehabilitation. These game-based rehabilitations reach widely a variety of user groups from children to the elderly who are suffering from impaired physical or cognitive abilities. At the same time, serious games for rehabilitation become specific for a target cognitive or physical treatment (or both).

The benefits of serious games have been measured and validated through their therapeutic successes in different application areas, for instance, stroke (Ma *et al.*,2008), diabetes (Brown *et al.*, 1997) and asthma (Lieberman, 2001). By comparison, serious games for cognitive rehabilitation (e.g., HERMES Maze and HERMES Waterfalls) are now of much interest in order to assist executive processing, visual attention and visual-manual coordination (Buiza *et al.*, 2009).

Indeed, some studies demonstrated that cognitive rehabilitation can be in parallel with physical exercises. For instance, Cameirão *et al.* (2009) have shown that the stroke patients had enhanced their cognitive and motor ability at the same time using a VR-based serious game.

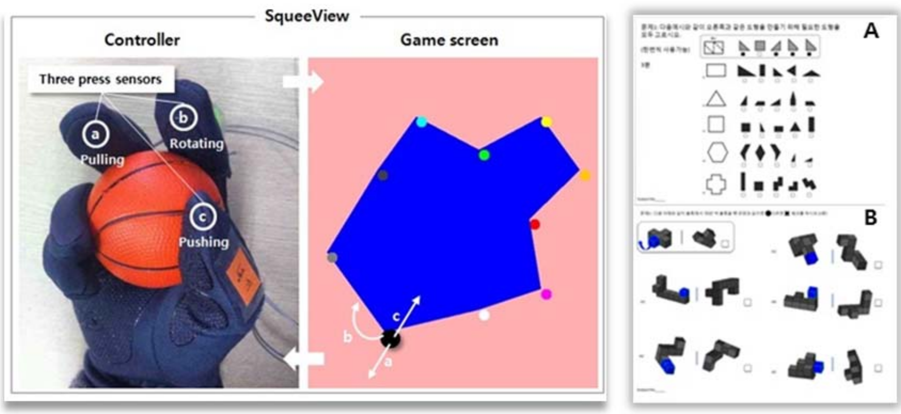
Game	Platform	Application area	Reference
Otago Exercises	Computer	Motor	Doyle *et al*., (2010)
ArrowAttack	Computer	Motor	Burke *et al*., (2009)
Cybercycle	Computer	Cognitive	Anderson-Hanley *et al*., (2012)
TheraGame	Computer	Cognitive and Motor	Kizony *et al*., (2006)
Silver Balance	Computer	Cognitive and Motor	Gerling *et al*., (2010)
Sphere chasing task	Computer	Cognitive and Motor	Cameirão *et al*., (2009)
HERMES Maze, Waterfalls	Interactive Table	Cognitive	Buiza*et al*., (2009)
Bowling	Mobile	Motor	Sunwoo *et al*., (2010)
Penguin Toss	Mobile	Motor	Sunwoo *et al*., (2010)

Table 1. Serious games for rehabilitation for the elderly (not exhaustive)

Table 1 lists some serious games for either physical or cognitive rehabilitation or both, for the elderly. Many of them have been developed based on a desktop computer platform, rather than a portable one. It is partly because recent serious games require high performance devices using sensing technologies (e.g., depth camera). In spite of a great evolution of mobile technologies, including processor speed, storage capability, sensing technologies, display resolution, it is still quite away from the adoption of mobile platform for playing serious games. Indeed, the serious games for rehabilitation are often very expensive, heavy and take up too much places to be installed at home. Therefore, most serious games for rehabilitation have been deployed in such as rehabilitation centres, rest homes, and hospitals. However, considering that most age-related illness in the elderly often needs a long-term treatment, the accessibility and personalisation is key to development, by which it means that the mobile platform would be of great value.

SQUEEVIEW: AN EMPIRICAL STUDY

That said, we developed a first prototype called '*SqueeView*'. It is mainly designed to prevent or treat the dementia for the elderly, by improving their cognitive ability (especially, spatial skills such as spatial visualisation and mental rotation) along with several finger motor skill exercises (Heyn *et al*., 2004). An empirical test of this prototype was firstly performed, its mobile version (tentatively called, '*SqueeView Mobile*') is now being developed. *SqueeView Mobile* will provide portability and accessibility to overcome the limitations of the first prototype. Indeed, the glove type of input device in *SqueeView* is not useable for the mobile platform, a new input system like Synaptics Fuse (http://www.synaptics.com/demos/fuse) is now thus being developed.



(a) (b)

Figure 1. (a) Schematic of '*SqueeView*'; (b) two types of cognitive test (A: Form Board Test VZ-1; B: 3D mental rotation test)

System Overview

'*SqueeView*' is inspired by the baby's finger movements, similar to squeezing a ball enhancing dementia patients' cognitive capability (Scherder *et al*., 2008). To play '*Squeeview*', a patient wears a glove, which integrates the three press sensors on the tips of the fingers (see Figure 1(a)). Each sensor detects separate finger actions: rotating for the index finger, pushing for the thumb, pulling for the middle finger, as shown in Figure 1(a). Using an ordinary elastic ball, the patient can naturally grasp it and manipulate each finger as she/he plays a real-time *SqueeView* game on the computer screen. *SqueeView* game comprises a series of geometric polygons. Each game needs to make a given polygon by using the three fingers, i.e., pulling (middle finger), pushing (thumb), or rotating (index finger) (Choi *et al*., 2012).

Participants/Apparatus/Procedure/Design

An experiment was designed to see the gaming effects of *SqueeView*. Thirty-five participants (avg.= 50.17 yrs.); twenty-three were male. They were later randomly assigned into either the treatment condition (i.e., *SqueeView*, n=25) or the active control condition (i.e., Tangram, n=10). Tangram is widely used for improving visuo-spatial skills (i.e. spatial visualization and mental rotation; Linn and Petersen, 1985) in the clinic. The assessment of cognitive capability was made by the two types of cognitive tests: *Form Board Test VZ-1*(Ekstrom *et al.*, 1976) and *3D mental rotation test* (Shepard and Metzler, 1971), as shown in Figure 1(b). A total duration of the experiment was 30 minutes (Step 1: Pre-test (5 mins.); Step 2: Main experiment (15 mins.); Step 3: Post-test (10 mins.)).

Results and Discussion

The mean scores of the cognitive assessment tests are shown in Table 1. In the *SqueeView* group, they were significantly increased from pre-test to post-test in Test A (t_{24}=-3.46, p<.05). However, it was not the case for Test B (3D mental rotation test). This result partially indicates that *SqueeView* could present some advantages over the traditional cognitive games (here, tangram). In particular, the current version of *Squeeview*, which provides two-dimensional game tasks, seems to be effective to separately enhance 2D visuo-spatial visualisation skills rather than three-dimensional mental rotation skills. Indeed, the results imply that jointly training cognitive and motor skills might be more successful for enhancing cognitive ability compared to a single cognitive training (i.e., Tangram). However, a careful interpretation of the results is separately needed, in that the 3D mental rotation test (i.e., Test B) did not reveal the benefits of *SqueeView*, which is planned to further examine in the near future.

	***SqueeView* (n=25)**				**Tangram (n=10)**			
Test types	Pre-test score	Post-test score	Change	*p*-value	Pre-test score	Post-test score	Change	*p*-value
Test A (max=5, min=-5)	-0.84	0.96	1.80	0.002*	0.6	1.9	1.30	0.10
Test B (max=5, min=-5)	3.08	3.48	0.40	0.32	4.2	4.2	0.00	1.00

Table 2. A comparison of progress in cognitive performances, * significance at 0.05 level

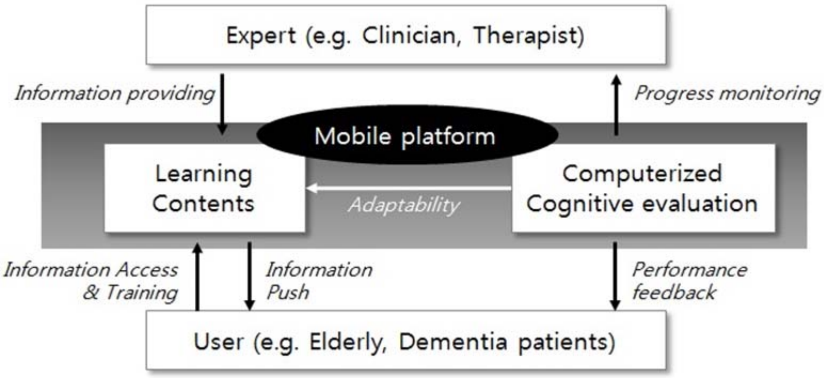


Figure 2. A new design framework of serious games for rehabilitation on a mobile platform

SQUEEVIEW MOBILE – INTEGRATING SQUEEVIEW WITH MOBILE LEARNING

That being partially identified the benefits of both '*SqueeView*' and its cognitive assessment tests, it can be more effective by being portable because a long-term training of dementia or cognitively impaired patients is essential (Volicer *et al.*, 2006). We are now sketching out '*SqueeView Mobile*' from two perspectives. First, as a series of cognitive assessment test are recently computerised as shown in such as Raven's test (Raven, 2000), '*SqueeView Mobile*' is also needed to present an instant feedback of their performance to further motivate the players. Secondly, not simply playing the mobile serious game, '*SqueeView Mobile*' can provide appropriate learning contents (e.g., dietary information, new exercise programs) under the mobile learning paradigm.

The main benefits of 'SqueeView Mobile' would be *easy access to information* and *adaptive learning contents*. First, through the middle layer of a mobile-based rehabilitation programme (as shown in Figure 2), clinical and training information can be effectively transferred across experts and actual user groups (mostly, the elderly). The learning contents include both game-based learning contents and non-clinical information, such as nutrition, dietary information, lifestyle consulting, and clinical schedules. Second, the notion of 'adaptability' of learning contents on a mobile platform is also applicable. As mentioned in the previous section, there are several types of cognitive assessments, which is often available only in the hospital or rehabilitation centre. Thus, a mobile-based rehabilitation programme is necessary to integrate both learning contents and cognitive assessment tools, so that they are quick to suggest best-possible game-based training and information. In addition, experts (e.g., clinicians, therapists) can monitor the progress of patient's cognitive or physical performance and adjust later her/his rehabilitation programme, if necessary.

We are currently updating *SqueeView* based on the proposed design framework above. In order to design a mobile '*SqueeView*', a similar prototype is now being made, like Synaptics 'Fuse™'(http://www.synaptics.com/demos/fuse). Also, a series of cognitive assessment sets have been computerized, that can be found at http://hci.hanyang.ac.kr/Experiment.html.

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Acceptance, Chances, and Problems of Mobile Learning in Vocational Education in Enterprises

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ABSTRACT
The increasing availability of mobile technology and devices like smartphones and tablet PCs leads to the fact that mobile learning (m-learning) is becoming a crucial feature in modern didactics with its focus on learners, situated learning and the use of media. In today's rapidly changing world a modern approach to didactics is necessary. Therefore m-learning also attracts more and more attention in the learning market and in vocational education in enterprises. Taking this as a starting point the following text is focusing on an essential aspect of m-learning in enterprises: Acceptance. According to decision makers in enterprises acceptance is directly related to chances and problems which are identified in the context of m-learning. As a basis for a successful implementation in vocational education in enterprises the acceptance by decision makers and by the learners is critical. That is the reason why we present a qualitative analysis of acceptance and the perceived value of m-learning in 10 German enterprises of different sectors.

Author Keywords
Mobile learning in enterprises, vocational education, decision makers in enterprises, acceptance of m-learning, chances of m-learning, problems of m-learning, Germany

INTRODUCTION

With the rapid spread of mobile devices such as smartphones and tablets that take mobile learning potential even further than laptops have ever done it becomes necessary to take a closer look at how m-learning can support further education in enterprises. In order to examine the current situation it is necessary to understand the previous state of knowledge.

The idea of m-learning as such is not actually a new concept but it focusses on the future (Hahn 2008). Various apps, e.g. in the gaming sector, already include fundamental aspects of learning. As such, m-learning has already found its way into mainstream applications and is widely used, especially by younger generations. Fairly new is the focus on complex aspects like virtual courseware. In former times virtual 'courseware' was designed and developed for specific devices whereas today m-learning opens the opportunity to use various devices and therefore opens more situative contexts for meaningful exploitation (for situated learning see Anderson / Reder / Simon 1996 and Cobb / Bowers 1999). The modern chance is to use commonly-available technology which already is in most users' possession paired with a platform that is available to everyone. Therefore m-learning's main aspect is the intersection of small mobile wireless computing and communication devices and e-learning.

Currently, there are many definitions of mobile learning. Most of them refer to learning possibilities in different places and/or at different times or, as Geddes (2004, 214) points out, "mLearning is the acquisition of any knowledge and skill through using mobile technology, anywhere, anytime, that results in an alteration in behaviour". El-Hussein / Cronje (2010, 21) state mobile learning is "any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners and mobility of learning".

With the increasing popularity of mobile devices it is important that adequate learning and educational approaches are developed, especially if benefits of technical devices are used effectively for a better learning. Mobile devices such as tablets (iPad, etc.), laptops or netbooks, and smartphones are used with growing frequency. Freimuth (2002) and Kynäslathi (2003) and Rey (2004) point to elements of mobile services that are crucial for m-learning:

- Efficiency: through learning opportunities at different locations
- Personal sphere: by learning in the personal environment of the learners
- Interaction connection: between learners as well as between students and teachers and also to available databases
- Context sensitivity: the ability to analyze information environment of the learner (situated learning)

- Regarding the argumentation of Kinshuk / Goh (2004) equal / equivalent content should exist on both stationary and mobile platforms.

Different aspects of mobility can be useful for learners. Kynäslahti (2003) identifies three different mobility aspects with: 1. Convenience, 2. Expediency and 3. Immediacy.

Stone (2010) brought up a guide for CLOs and training managers to deal with mobile learning in enterprises. He mentioned the use of getting "support at a critical moment of need."

Several studies which are focusing on this important aspect or briefly touching the topic already exist, like the research of Yi / Liao / Huang / Hwan (2009). But they more or less all emphasize quantitative research approaches, either focusing on technology acceptance like Williams (2009)., e.g. using the TAM- Technology Acceptance Model of Davis / Bagozzi / Warshaw (1975), or paradigm changes in general educational contexts - Rosman (2008), teacher training contexts - Seppälä and Alamäki (2003), or higher education contexts Habboush / Nassuora / Hussein (2011) and Donaldson (2011). Therefore a lack of information can be found and shown in qualitative research dealing with acceptance, chances, and problems in the field of vocational education via m-learning in enterprises.

All the existing research focuses on how m-learning works and how it can be defined and analyzed. Mobile Learning actually seems to be a promising emerging market for the education industry. But if implementation of m-learning as vocational education in enterprises is desired, the first step has to be a look at the acceptance at individual level with focus on decision-makers and learners.

This gap should be filled a little more by the following qualitative research study (see also Motiwalla 2005).

AIM AND RESEARCH DESIGN OF OUR STUDY ON ACCEPTANCE OF MOBILE LEARNING IN VOCATIONAL EDUCATION IN ENTERPRISES

These arguments lead to the aim of our study. The purpose of this article is to reflect on and understand the position of mobile learning in vocational education in enterprises. Main objective of our research is to clarify which issues are addressed when decision makers responsible for vocational education and human resources management in enterprises of different sectors are reflecting on the acceptance of mobile learning (see also Akour 2009) concerning their educational measures in initial and further education at enterprises. Therefore sub-aims of this study were to illustrate the benefits and problems which are discussed by this target group.

In order to identify the appropriate arguments we decided to run a qualitative research. Data was collected by means of semi-structured interviews based on an interview guideline with responsible decision makers in enterprises. The narrative parts of the interviews are suited to delineate personal meanings (Flick 1998; Strauss / Corbin 1998) and experiences.

Our interviews were documented via audio-recordings, then transcribed and structured via argumentation tables. Content analysis was used to analyze and categorize the data. In order to assure trustworthiness the interviews were randomly assigned and analyzed by the authors. In the field two interviewers acted together to create credibility, validity, and the securing of the identity of the interviewees. Concerning validity it can be stated that all categories that emerged from the data are consistent with the understandings of the participants. The average duration of each interview was 15 minutes after a first informative telephone contact of about 5 minutes. All interviews were conducted in May 2012.

RESULTS OF OUR STUDY ON ACCEPTANCE OF MOBILE LEARNING IN VOCATIONAL EDUCATION IN ENTERPRISES

The interviews focused on ten questions about learning with mobile devices in general and in the enterprise of the interviewees. The decision makers chosen to be interviewed were given the chance of talking about experiences, opinions, plans, and strategy concerning m-learning. The ten guiding questions the interviews were based on are presented below:

- Have you been confronted with m-learning in any way in your company?
- In general, what is the relevance of learning with mobile devices?
- What is the relevance of learning with mobile devices in your company?
- In general, which role will learning with mobile devices play in the near future (next 5 years)?
- Which role will learning with mobile devices play in your company in the near future (next 5 years)?
- Would you say that using mobile learning in companies makes sense or not?
- Which advantages do you see in learning with mobile devices?
- Which disadvantages do you see in learning with mobile devices?
- Would mobile learning fit into your current apprenticeship structure or your further education program?

- Please describe an example of how the integration of learning with mobile devices into your company could make sense.

One of the first things that became obvious was that an overwhelming majority (90%) expected m-learning to become very important, not only in their company but in vocational education in general. However, at the same time only 10% of the companies are currently using mobile devices for learning, and even the examples that exist are still on a very basic level, given the potential that m-learning offers.

This situation demands a closer look at the reasons behind the hesitance to implement m-learning in enterprises. Half of the companies have stated that mobile devices (mainly smartphones) have already become part of their daily work and are used extensively in many areas. The main use of smartphones seems to be staying in touch with mobile employees and the main use for tablets seems to be presenting products or information to clients. So why haven't mobile devices found their way into the education programs of these companies yet?

Acceptance of m-learning in enterprises

A direct answer can be found in most of the interviews: Since learning through mobile devices is such a new concept most decision makers lack the knowledge of how these new approaches could work or how they could be implemented. A more indirect answer to this question can be obtained by taking a closer look at the acceptance of mobile learning in companies. In order to get a more complete picture of how these companies feel about m-learning we have grouped the statements into categories that have a critical influence on the acceptance level of mobile learning. These categories are the advantages, disadvantages, and expectations associated with the use of mobile devices for learning. An overview of the items in each category is given below. The items are loosely sorted by how frequently they were mentioned with higher frequencies at the top.

Figure 1. How decision makers in enterprises see the acceptance of the use of m-learning

While many advantages speak for the use of mobile learning in enterprises decision makers see a number of disadvantages that in their perception haven't been addressed yet. They also have expectations that need to be met before they actively plan the introduction of m-learning.

A closer look at the advantages and disadvantages listed reveals that many decision makers might be thinking of m-learning as simply moving their current learning methods like seminars and handbooks to mobile devices. This is very evident when considering items such as "easy to switch device off if learning content is irrelevant" and "no individual questions and answers". However, modern m-learning approaches can take advantage of advanced smart technology like taking the learners to the appropriate level of learning content that they need and supporting them according to their individual skills. Very few of the decision makers thought of new educational approaches with m-learning like "individualization of learning content", one of the advantages listed. This could be either because they aren't aware of solutions that exist or because the solutions they need in their enterprise aren't available yet. In any case, this is a clear challenge for m-learning providers to become active and either develop the right m-learning methods and content or to keep decision makers better informed about their products.

The expectations show that there is also uncertainty if the new approaches work ("needs to be tested more") and if they can provide learning results that are as good as the current approaches ("learning outcomes need to be at least as good as in seminars"). One of the expectations ("m-learning should not be used for amusement and games") even shows plain doubts that new approaches which come with m-learning like serious games could actually be a good alternative way of learning. All of this shows how important it is to evaluate m-learning approaches and methods scientifically and find out how effective these approaches are, at least until enterprises have had enough time for practical experiences. This would be the challenge for the scientific community, especially universities.

The uncertainty of decision makers also highlights the need for showcases and best practice cases. The situation indicates that m-learning in enterprises is still in its infancy, and it will take an effort on several levels in order to turn it into an important part of further vocational education.

Chances for enterprises that make use of m-learning

Several decision makers pointed out that mobile learning would be most beneficial for large enterprises. When looking at the aspect of "chances" which are seen by the decision makers in companies, three categories can be distinguished. On the one hand, respondents list chances in the category usability and aims. This category can be characterized as chances concerning main future company goals and aspects which create additional usefulness future. On the other hand the decision makers focus on chances which can be summarized under the category of organization. The chances they see under this category have in common that these are all aspects that improve the processes and organizational structure of measures, courses in the field of initial and/or further education in enterprises, and learning environments. Last but not least the respondents emphasize chances which can be grouped into the category learning. The indicated chances in this category refer to learning contents and learning aims as well as an improvement of the learning process of the users of mobile learning.

The main statements outlining the chances that mobile learning provides for these companies are summarized in the order of their frequency, grouped by category, below:

usability and aims

- making use of company's online resources
- attracting new generations
- saving money

organization

- good way of putting information (handbooks, presentations) in the hands of employees
- use of smartphones as a quick way of distributing information
- essential for keeping mobile employees connected
- good for preparing learners for seminars and for providing material after seminars
- making information available that's up to date
- could replace the mandatory seminars
- employees can take device home and have learning content available

learning

- good for learning about company's products
- individualized content for learners
- good for learning languages

- lets users provide feedback
- using simulations to make understanding easier

Once again it becomes clear that the dominant way of understanding m-learning in enterprises is the transfer of established education methods to mobile devices ("good way of putting information (handbooks, presentations) in the hands of employees"). However, ideas of new approaches are starting to appear as well ("individualized content for learners", "lets users provide feedback", "using simulations to make understanding easier"), even if decision makers admit to not knowing very much about these approaches. One of the very interesting chances seen by decision makers is the opportunity to make the company's apprenticeship program and its further education more attractive to young generations that are more used to mobile devices. This is seen as a good way of attracting high potential employees to the company.

Problems for enterprises that make use of m-learning

While decision makers were quick to point out disadvantages they only came up with very few things that they consider real problems for the introduction of m-learning in their companies. Problems which go hand in hand with m-learning in the assessment of the decision makers in companies can also be structured in three categories. The respondents differentiate between purpose-related problems, cost-related problems, and problems concerning the acceptance and ability in enterprises to deal with matters of m-learning. Their biggest worries are summarized, grouped by category, in the order of their frequency below:

cost efficiency

- the costs for the technology would be very high
- the costs for the content could be high

purpose adequacy

- uncertain if results will be good enough to replace current learning methods or if it can just be an addition
- no content available for company's purposes
- no technology available for company's purposes

ability and acceptance

- m-learning will be tested but it is a question of acceptance by the employees
- willing to introduce m-learning but company doesn't have the knowledge

The problems mentioned are definitely not insurmountable obstacles but they are currently keeping the interviewed companies from embracing m-learning immediately. Solving these problems would require a good cooperation between companies and the providers of m-learning solutions, especially when it comes to developing employee-friendly solutions, creating products with convincing learning results, and designing cost-efficient solutions.

CONCLUSIONS

In general it becomes clear that companies expect mobile learning to become very important in the coming years. Most of them are eager to build up something but most decision makers also admit to not knowing exactly how since mobile learning is relatively new. The chances that are seen in mobile learning in enterprises are still very simple implementations, with independence of location and time or the quick distribution of information as the main ideas. These ideas are based on traditional education approaches and take into consideration the value that can be added through the electronic devices. Few decision makers are familiar enough with m-learning potential to imagine how this approach can change the way of learning. As one of the rare examples for this, individualization of learning content was pointed out. The chance of reaching new generations through m-learning also plays a big role in the companies' willingness to give m-learning a try in the near future.

However, at the same time decision makers are also hesitant to make use of m-learning immediately for various reasons. In order for m-learning to find its way into enterprises it will be necessary to educate decision makers on how mobile learning could work for them. Currently they are aware that it exists but in most cases only have a vague idea what it could look like. Ideas that exist remain on a relative simple level of taking advantage of the m-learning potential, such as providing a way of finding information quickly or the use of podcasts. At the same time there seems to be a lack of good solutions on the market and providers of mobile learning solutions are called on to offer more educational products that can be used for m-learning.

Acceptance of m-learning as a future way of further educating the workforce is surprisingly high. Apparently decision makers are open to innovation in this area if they see that mobile learning solutions can fulfill three critical requirements:

Acceptance by the learners

Depending on the industry the workforce is expected to accept the use of mobile devices or electronic devices for learning more or less. With younger generations decision makers expect the acceptance to go up quickly and even predict that mobile learning will be a lot more attractive than holding seminars.

Good learning results

If an enterprise relies on mobile learning the learning results should be at least as good as the results of current methods like seminars. This of course demands scientific studies of effectiveness and showcases to convince decision makers.

Acceptable costs

The costs involved should not be higher than the current costs of educating the workforce. Many decision makers are under the impression that m-learning would be expensive because of the high costs of the technology involved. Saving potentials are rarely seen. In order for m-learning to be accepted in enterprises cost advantages will have to become more apparent.

The first step of a practical solution to overcoming the main barriers of adoption could be the creation of showcases in which different partners work together on implementing a mobile learning approach in a company, study the results, and publish them. This would require a company willing to try new learning approaches, an academic partner to study the results, a provider of mobile learning solutions, and, ideally, a dissemination partner like an association or a government organisation. The second step would have to be informing the decision makers. The showcase would provide interesting facts to prove that m-learning is a viable alternative, and this would have to be supplemented with information on how other companies could get started with their own m-learning projects.

It is important to remember that the study only shows the current situation in Germany. Further studies would be needed to expand the result to a European view or even a more global view. The role that mobile technology plays in various countries suggests that enterprises are in different situations and at different stages of introducing m-learning into their vocational education and their on-the-job training. Similar studies in other countries would allow an interesting comparison.

Since the development of mobile devices proceeds at a very high pace and the role of mobile devices in people's daily life increases rapidly the result of the study is only meaningful for a short time. It would make sense to repeat the interviews every year and examine how the acceptance and the use of mobile devices for learning purposes in enterprises change.

It is essential to study how new technologies like m-learning can contribute to improving the quality of education (cf. Laurel, 1995). Since teaching and learning processes both involve teachers and learners it only seems logical to expand the scope of this study and include the views of both groups. This would add to the impressions provided by the decision makers by using the results and categories of this study as a starting point for future interviews and surveys. In addition it would be useful to find out how current and future generations of employees want to learn, how easy it is for them to accept m-learning, and what their expectations of further education provided by their employer are.

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Suitability of Mobile Learning to enhance English language learning: A survey among University of Colombo School of Computing Students.

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ABSTRACT

Mobile learning is one of the major developing areas in recent years in educational field. Power of computers and laptops has changed the way learning happen and made ease of access to all materials and resources. Growing amount of literature in the area of mobile learning depicts the increasing use of mobile technologies for learning. This study is a part of the ongoing research in University of Colombo School of Computing (UCSC) based on enhancing English language learning among UCSC undergraduates. This paper focuses on a study which was conducted among University of Colombo School of Computing undergraduates in order to find out the potential of mobile learning to enhance English language proficiency. The methodology used for this study was an online questionnaire survey. The analysis of the results depicted that most of the students are having positive attitude towards mobile learning and believe that mobile phones could be used to enhance English proficiency. Further suggestions have been included to consider on enhancement of oral communication skills. The paper concluded with few implications to enhance mobile language learning.

Author Keywords

Mobile Learning, Questionnaire survey, English Language Learning and University of Colombo School of Computing

INTRODUCTION

Mobile learning is one of the major developing areas in recent years in educational field. Power of computers and laptops has changed the way learning happen and made ease of access to all materials and resources. The use of mobile phones have transformed the way of carrying on activities by allowing easy interconnections and enhanced communications. Many researches have pointed out that mobile phone usages have increased dramatically in SriLanka due to the severe competition among the mobile service providers. It is also identified that the numbers of mobile users in SriLanka have increased up to 15 million [http://www.lankabusinessonline.com/fullstory.php?nid=1180937564].

This study will focus on finding suitability of m-learning among the university students of SriLanka by selecting the target audiences as UCSC (University of Colombo School of Computing) students. An online questionnaire was used to identify and analyze the factors related to mobile learning among UCSC students.

REVIEW OF LITERATURE

There are many studies which have already been done in the area of mobile language learning. According to Attewell (2004) there are wider varieties of mobile phones available in the market which caters range of customer tastes and life styles. Some devices are aimed at business users and are marketed primarily as business communication devices. Some devices including smart phones have virtual pop up QWERTY keyboard and hand writing recognition. They also contain a video camera, music player, radio, voice memo recording, games, and e-mail, internet, and organizer functions.

Defining Mobile Learning

There is no proper definition of mobile learning as many authors have derived with various definitions. The understanding of mobile learning will itself influence the progress and direction of mobile learning and its perception and acceptance by the wider educational community. According to (Traxlor, 2005), mobile learning is, „any educational provision where the sole or dominant technologies are handheld or palmtop devices". This definition may mean that mobile learning could include mobile „phones, smart phones, personal digital assistants (PDAs) and their peripherals, perhaps tablet PCs and perhaps laptop PCs, but not desktops in carts and other similar solutions" (Traxlor, 2005).

Mobile devices network availability and penetration is happening at a dramatic pace in developing countries (Gounder, 2011). Meanwhile a study which has been conducted in University of Colombo School of Computing on developing mobile applications based on the existing Moodle based e-learning platform has depicted that M-learning extensions cannot be developed to an existing e-learning environment without changing the pedagogy and design of learning content. Pedagogy and learning content must be changed to make the learning suitable, which should be considered when transferring from E-Learning to M-Learning. Further, during the paradigm shift, we will have several new opportunities as well as we have to sacrifice some good practices in the previous paradigm (Hewagamage, 2011).

Mobile Language Learning

There are few studies which have been concentrated on identifying the use of mobile technologies in use of English language learning. A study done by Al Aamri and Kamla Sulaiman is an example for this. They have studied the current use and practices of mobile phones in the process of learning English Language by Sultan Qaboos University students. Author has identified the existing uses and practices, through a questionnaire and states that "It has found that students use mobile phone in learning, but in a very limited way." (Aamri& Suleiman, 2011). Another study has been done by Burston, J. (2011) on realizing the potential of mobile learning for language learning by identifying the obstacles in mobile learning as Intrusiveness, Cost, Practical and technological constrains and Theoretical & pedagogical foundations. In sum, as mobile phone features have increased, while their cost decreased, attention has increasingly focused on them as an ultra-portable language learning tool. Above all, what has attracted interest in the use of mobile phones as learning devices is their potential to support anywhere, anytime, access (Burston, 2011).

THE STUDY

Methodology

The methodology used for this study was an online questionnaire which was issued among all UCSC undergraduates. The survey was consisting of mixed methods of questions to gain statistical responses. Students who participated in this survey were from two different disciplines, which were „Computer Science‟ and „Information and Communication Technology‟ accordingly. The questionnaire was distributed among 800 students of UCSC and out of them, 189 responses were received within 3 weeks period. The response rate was 23.75 %. Most of the questions were closed ended where few open ended questions also were included to get respondents‟ comments.

Objectives

The objective of the questionnaire was as follows: Part 1 collected little general information about their course of study. The second part focused on collecting information related to mobile usage. Third part was consisting of questions related to students learning preferences and fourth part was designed in such a way to identify the students‟ attitude towards mobile learning. Most of the questions were closed ended with few open ended questions to get respondents comments.

Findings

Part One: General Information

QUESTION 01: Course of Study

The first question was with regard to their course of study and out of the whole respondents, approximately 29% were from Information and Communication Technology (ICT) and 71% were from Computer Science (CS).

QUESTION 02: Do you have a mobile phone?

Total number of respondents where 189 and out of the whole respondents, only 1 person did not own a mobile phone.

PART TWO: WITH REGARD TO MOBILE USAGE

QUESTION 03: What type of phone are you using?

This question was asked in order to identify the widely available types of phones among the university community. The students were allowed to select the answer among 1.Basic java enabled phones 2. Smarts phones 3. Mobile with basic features such as voice call and SMS. Around 51% of the students owned a phone which have basic java enabled phones, and 13% of students were having a smart phone. 36% of the students are having a mobile with basic feature, which are enabled with voice calls and only SMS.

QUESTION 04: What are the features you mostly use in your mobile phone?

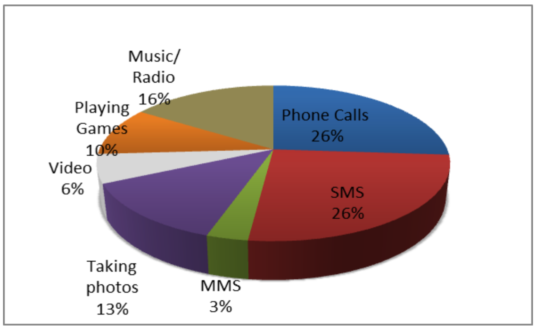

Figure 1. Mostly used Features in the mobile

Figure illustrates that students are mostly using the mobile phones for voice calls and send SMS. It is also noted that there is equal usage of voice calls and SMS. Further MMS is not much used within the student community. Students were asked to state, if there were any other functionalities which they use other than the given types. 13 respondents stated that, internet is one of the features which are mostly used. Other than that, alarms, reminders, calculator and stopwatch were also given as answer.

QUESTION 05: Do you use your phone for Internet browsing? Please state if there are any specific reasons for not using the internet.

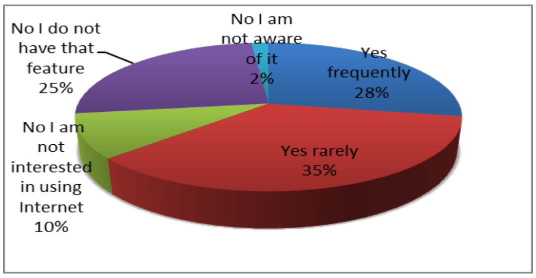

Figure 2. Internet usage via mobile

According to the results, only 28% of students are frequently using the internet via mobile. 35% of students are rarely using the internet while 25% of respondents are not having that feature in their mobile. 10% are not interested and 2% of respondents are not aware of that feature.

While analyzing the reasons for not using internet, it was notable that the constrains were cost associated with the internet and the virus threat. Other reason was that they did not need to access the internet via phone, since they were using it in the computer.

PART THREE: WITH REGARD TO LEARNING HABITS

QUESTION 06: Rank the following options with respect to your learning style.

	1	2	3	4	5	6	7	Responses	Total
Text	29%	16%	12%	11%	12%	8%	11%	153	15%
Listening for instructions	20%	17%	14%	19%	17%	8%	6%	153	15%
Watching video	20%	22%	16%	18%	18%	5%	1%	152	15%
Role play/ Drama	2%	1%	5%	8%	8%	38%	38%	131	13%
Games	4%	7%	8%	7%	12%	27%	34%	135	13%
Interacting with friends	19%	22%	22%	18%	13%	2%	3%	156	15%
Questions and answers	12%	18%	25%	21%	15%	7%	1%	153	15%

Figure 3. Learning style

29% of students have placed text as their first preference, where role play has been placed at the least preferred state.

Listening and learning through video tutorials have been placed as the first option by 20% of students. Within these two options, Watching video has gained more weight as 2nd rank, hence it would be considered as the second preferred option. The fourth preferred option would be considered as Interacting with friends since 19% of respondents have ranked it in the first place. Learning through questions and answers follows as 5th, as 12% of respondents have placed it at the 5th place. Games and Role play would follow the rest as 6th and 7th preferred options accordingly.

QUESTION 07: Does your English knowledge affect learning of other studies?

When raising the question with regard to the impact of English language in other studies, 65.27% of students feel that English affects the learning of other subjects while, 34.73% of students don‟t.

QUESTION 08: Please state the barriers you face in learning English.

This was an open ended question which focused on identifying the barriers which exist in learning English. Most of the students have stated that they are having problems with vocabulary and oral skills. Around 30 students have stated that they are having difficulties in speaking English and around 20 of students have stated that they are having problems related to vocabulary and grammar. Around 5 respondents have stated that they never practice English in day to day life. Some students state that their economic status has become a barrier to learn English. Some state that they are having social barriers and fear to practice in English. Some respondents state that learning English depends on the environment and they are not having an environment to practice in English. Students also state that Sinhala is very useful to understand things when comparing to English.

QUESTION 09: Which of the following aspects you would like to enhance in future?

	Not important	Important	Highly important	Responses	Total
Read	13%	40%	47%	152	25%
Write	8%	44%	49%	156	25%
Speak	1%	19%	81%	161	26%
Listen	5%	38%	57%	151	24%

Figure 4. Learning aspects to be enhanced

In this question, 47% of respondents have identified that reading is highly important when compared to the 40% which is important. Most of the respondents have given highest priority to high importance in speaking.

QUESTION 10: What was your O/L result for English?

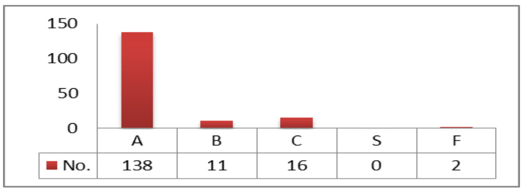

Figure 5. O/L results in English

It was noted that around 83% of respondents have got Distinction in English ordinary level exams.

QUESTION 11: What was your A/L result for English?

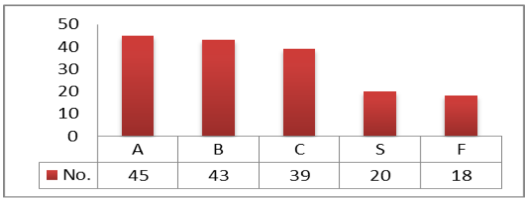

Figure 6. A/L results for English

28% of respondents have got „A" grade when comparing 26 percent who have got „B" grades. 12% have got simple passes and it is notable that around 11% of respondents have got failures in their A/L exams for English.

PART FOUR: ATTITUDES TOWARDS MOBILE LEARNING

QUESTION 12: Please select the scale of agreement from below statements.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Responses	Total
I believe mobile phones could be used to teach/learn English.	18%	51%	27%	4%	1%	154	9%
I am willing to purchase a mobile phone with advanced features if it will help me to improve my learning.	17%	48%	20%	12%	3%	154	9%
I would like to install a learning application in my mobile phone to improve English proficiency.	32%	45%	18%	4%	1%	154	9%
I do not mind paying for Internet connection for my mobile, if I can learn through my mobile.	10%	32%	32%	25%	1%	154	9%
SMS based learning application would be ideal to promote English learning among UCSC undergraduates.	10%	36%	27%	25%	2%	154	9%
Learning through mobile devices will help me to utilize my time productively.	27%	46%	19%	6%	1%	154	9%
A person could learn properly through online lessons if it is designed properly.	47%	40%	12%	1%	0%	154	9%
I think I can improve my English speaking skills through a mobile.	10%	50%	29%	10%	1%	154	9%
I believe mobile learning will not provide any advantages for me.	1%	5%	19%	60%	16%	154	9%
I think learning through mobile phone will not build teamwork and collaboration.	7%	25%	32%	30%	6%	154	9%
I believe learning through mobile will increase the cost of learning.	3%	35%	35%	23%	3%	154	9%

Figure 7. Attitude towards mobile learning

Respondents were provided with 5 point likert scale where each choice were ranked as „Strongly Agree", „Agree", „Neutral", „Disagree" and „Strongly Disagree".

51% of respondents agree that mobile phones can be used to teach / learn English when comparing 27% of respondents are neutral with that statement. 48 of respondents are willing to purchase a mobile phone with advance features if it will help improve their learning, while 12% of respondents disagree with that statement. More than 75% of respondents are having tendency towards installing a learning application, in order to improve English language proficiency where 32% strongly disagree the statement and 45% agree. The statement which was issued with regard to the cost of internet connection has gained neutral response. 32% have agreed the statement while 32% have provided neutral response. It is also noted that 25% of the respondents have disagreed the statement. 36% have agreed that SMS based learning application would be ideal to promote English language learning and 27%have provided a neutral answer with comparing to those 25% who have disagreed the statement. 27% have strongly agreed that learning through mobile devices will allow utilizing the learners time effectively. 46% have agreed with the statement with comparing to the 19% who have provided neutral answer. The statement which was issued regarding the online lessons, have more tendency towards supporting the online learning. 47% strongly agrees that a person could learn properly through online lessons if it is designed properly, while 40% are agreeing with the statement. When asking about the speaking skills, 50% of respondents have agreed that English speaking skills can be improved through mobile, when comparing to those who have provided neutral response.

Rest of three statements was negative statements, which depicted that 60% of respondents disagreed the statement that mobile learning will not provide any benefits. 25% of respondent agreed that mobile learning will not build teamwork, while 32% provided neutral response. When asking about the cost, 35% agreed that mobile learning will increase the cost of learning while similar percentage of respondents provided neutral answer. 23% of respondents have disagreed the statement.

QUESTION 13: Please enter your further comments or suggestions in below text box with regard to the study.

This was an open ended question which required the comments of the respondent. Many comments were received, where most of them were towards mobile learning. Most of the requirement was to suggest a method to enhance oral communication as well as vocabulary. Cost was identified as a barrier for mobile learning, and SMS based learning also was suggested. It was also noted that while there are advocates for mobile learning, still there were opposers as well.

ANALYSIS

Part One: General Information

Out of those who responded the survey, 71% had a computer science background and 29% were from Information and Communication Technology. Since more than 99% of respondents own mobile phone, we can come to a conclusion that almost all of the UCSC students are having mobile phones.

Part Two: With Regard To Mobile Usage

There is a high tendency of using java enabled mobile phones among the university society when comparing to smart phones and basic phones with only SMS and voice call facilities. Most of the features which are used in mobile phones are obviously voice calls and SMS. Most of the respondents are using the mobile internet facilities rarely due to various reasons; meanwhile there is a considerable portion of respondents who uses the mobile internet frequently. The reasons for not accessing internet via mobile have been identified as cost and security related issues. It is also identified that around 1/4 of the respondents are not having internet facilities in their mobile.

Part Three: With Regard To Learning Habits

According to this question, currently, students are more towards learning through text. Role Play/ Drama have been the least preferred option by the students. 65% of respondents have agreed that knowledge in English language has affected other studies. As the barriers to learn English, respondents have stated various reasons; while some have stated that there are no barriers. Most of the respondents have stated that the major problem with the language is the oral skills. Meanwhile around 20 respondents have stated that they are having difficulties with vocabularies and harsh terminology. Grammar also has been identified as difficult area. Some students state that their economic status has become a barrier to learn English. Some state that they are having social barriers and fear to practice in English. Some respondents state that learning English depends on the environment and they are not having an environment to practice in English.

According to the question based on the priority for four Language Learning aspects, speaking has been placed as the most important which should be enhanced in future. Considerable amount of respondents also have identified other areas to be improved as well. When analyzing the results of the respondents, more than 80% have got „A‟ grade in their ordinary level examination. It is also to be considered that, there is a basic requirement for Information and Communication Technology is to get at least „C‟ pass in order to enter the university. Although there more than 99% of respondents have passed English in their ordinary level exams, more than 11% of students have failed English in their advanced levels. Only 28%of students have got „A‟ grades in A/L.

Part Four: Attitudes towards Mobile Learning

51% of respondents agree that mobile phones can be used to teach / learn English when comparing 27% of respondents are neutral with that statement. 48% of respondents are willing to purchase a mobile phone with advance features if it will help improve their learning. It is also noted that majority of the students are willing to install a third party application in their phones if it will enhance their proficiency. The statement which was issued with regard to the cost of internet connection has gained neutral response. 36% have agreed that SMS based learning application would be ideal to promote English language learning and 25% have disagreed the statement. Most of the respondents have agreed the statement saying that learning through mobile devices will allow utilize the learners time effectively. The statement which was issued regarding the online lessons, have more tendency towards supporting the online learning. Students also agree that they can learn through online lessons if it is designed properly. When asking about the speaking skills, 50% of respondents have agreed that English speaking skills can be improved through mobile.

Rest of three statements was negative statements, which depicted that 60% of respondents disagreed the statement that mobile learning will not provide any benefits. 25% of respondent agreed that mobile learning will not build teamwork. When asking about the cost, 35% agreed that mobile learning will increase the cost of learning while similar percentage of respondents provided neutral answer.

The open ended question which was issued with regard to gathering the learners‟ additional comments as received various answers. Some have suggested that mobile learning would be suitable for language learning where some have suggested that this won‟t be suitable. Most of the answers are towards mobile learning and pointing out the features which should be included. Some respondents feel that cost will be a major constraint and it should be considered when proposing the solution. Some suggest that all four aspects of language learning (Reading, Writing, Speaking and Listening) should be included in the solution. There is a tendency towards game based learning as well. Some have suggested introducing a mobile application, instead of mobile web. Since there are basic phones widely available, some respondents have suggested that SMS based learning will be suitable for those who don‟t have phone with advanced features, but will be an interruption to day to day activities. Other than these there was a suggestion to consider the voice recording functionality which is embedded within most of the mobile phones. Some negative statements were also found where some suggests that mobile learning will not be suitable for English Language learning. It was also noted that there are opposes with an argument of being against to language learning through mobile learning.

LIMITATIONS AND FUTURE WORKS

The survey results which have been presented here is with regard to mobile usage and practices among students of University of Colombo School of Computing, have presented certain scenarios which can be worth in investigation. According to the results, the study can be continued with means of providing a mechanism to enhance voice learning aspects of the students based on java enabled phones which is widely used in the university community. Meanwhile another solution will be provided to overcome the shortcomings in vocabulary fluency. The most suitable channel for this would be SMS, which is widely used by the respondents. As limitations for the current work, the survey was distributed among more than 800 students but only received 189 responses, which is lower response rate.

CONCLUSION

This paper attempts to identify the level of English language knowledge and learner preference for mobile language learning in University of Colombo School of Computing. This is an ongoing research and this survey has been conducted as a part of the research. The survey analysis of the results depicted that most of the students are having positive attitude towards mobile learning and believe that mobile phones could be used to enhance English proficiency. The paper has concluded with few implications for future research based on enhancing oral communication in English and vocabulary enhancement. Further, majority of the respondents ponder that they are weak in oral skills. When questioning about SMS based learning, students have agreed that SMS based learning could be used in language learning. Meanwhile, when analyzing the technical aspects of the current use of mobile phones among the university community, majority of the students are using basic java enabled phones and there are considerable amount of students who use their mobile phones to access the internet.

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Impact of tablet computers and eBooks on learning practices of law students

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ABSTRACT
In this paper we present first results from an ongoing pilot study at the law faculty of the Open University of the Netherlands. Students participating in a bridging course have been given the choice between traditional study methods and the use of a tablet-computer equipped with digital learning resources and electronic textbooks. In this paper we report first qualitative findings from this pilot study. A monthly questionnaire has been administered to let students rate statements on a 7-point-likert-scale. These findings are enriched with results from a focus group session in January 2012. The results are discussed and an outlook on future work is provided.

Author Keywords
pilot study, qualitative study, tablet-computer, iPad, law, eBooks

INTRODUCTION
With the growing diffusion of tablet computers the electronic book (eBook) has been receiving more and more attention in different business sectors. Large publishing houses have reported for the first time more sales of electronic books than printed books. Also in the educational context the introduction of tablet computers and eBooks is intensively discussed in several countries. To date, several studies have been conducted mostly using traditional eReaders instead of tablet computers. Three types of studies have been conducted about the effects of electronic books: Media comparison studies (printed books vs. eBook), literacy studies and studies that focus on the change of learning practices.

Prensky (2011) argues for the ban of traditional books in higher education institutions. He proposed this step as a sign of "moving education into the future". Besides this mere and ungrounded opinion about the role of electronic books there is also empirical work available. Woody, Daniel, & Baker (2010) have focused in their study on preference of students between electronic versions of a book and printed textbooks for learning. In their study the authors have taken into account the influence of computer experience on this choice. They found that students prefer traditional books instead of eBooks no matter how much computer experience they have. No significant differences have been found in terms of learning results. Rockinson-Szapkiw, Holder, & Dunn (2011) compare the motivation of students for a number of learning tasks when using eBooks in comparison with traditional books. The authors found a significant difference in motivation between the groups. The students with eBooks had a significant higher motivation to study the instructional material as the other group. It is an open question if this increase of motivation is only a novelty effect or if the effect would sustain a longer period of time. Only a longitudinal study would be able to answer this question. Weisberg (2011) has conducted a longitudinal study over 2 years in a business school. In this study the use of 5 different devices for reading electronic books are analyzed and compared with a group using traditional textbooks. In the study no significant difference in terms of learning results is found. The study shows that the acceptance and usage of the devices as primary or secondary sources for learning has grown during the study because of the further development of the devices but also because of market penetration and prior experiences with these devices.

Another group of studies has focused on the effects of eBooks on literacy and especially reading skills. Korat (2010) has conducted studies about the effects of eBooks on word reading, story comprehension and vocabulary of kindergarten children. The group that used en eBook reader and eBooks shows significantly better results in understanding of word meaning and word comprehension. In a different study (Shamir, Korat, & Shlafer, 2011) the authors have analyzed the impact of a tutor-supported use of eBooks versus individual usage on the writings skills of kindergarten children from families with a low socioeconomic status. The study shows that only a tutor supported scenario can lead to significant improvement of emergent word writing and phonological awareness. Jones & Brown (2011) have analyzed effects of electronic books on reading engagement of third-grade students. A traditional textbook, a website containing a collection of online-books for children and an eBook have been compared in the study. The study shows that the possibility to chose a book on the website had an effect on motivation and engagement of students. No significant effects have been found in the comprehension results of the book versus the electronic book.

Nie, Armellini, Witthaus, & Barklamb (2011) have focused in their study on the effects of eBooks and eBook-readers on changing learning practices. In the study they compared the use of an eBook-reader in a master program for occupational psychology and a master program for education. Both groups report an increased flexibility in their learning due to new learning contexts that occur through the portability of the devices. Learners could use small time-slots more effectively and they developed new study strategies through notes, annotations and the preparation of assignments.

In this paper we present first results from an ongoing study at the law faculty of the Open University of the Netherlands. 12 students of a pre-master preparatory course have been provided with tablet computers equipped with content of 4 courses. In the study we have combined a mixed-method approach combining quantitative and qualitative measures. Our research question was if we can confirm findings from the study by Nie, Armellini, Witthaus, & Barklamb (2011) and how learners experience new learning practices and learning opportunities. In the next section we provide details about the study, discuss results and limitations and provide an outlook on future research.

IPAD STUDY

At the Open University of the Netherlands we offer several bridging courses preparing learners to enter study programs on the master level. Learners who do not fulfil all requirements for a master program usually choose these courses. In the summer 2011 two versions of the bridging course for the master program in law have been offered to students. A traditional version with printed study books, textbooks and law digests and a digital version containing all the material in a digital version on a rental tablet computer.

Participants

In September 2011 we have kicked off the pilot study with 12 students who have chosen the fully digital version of the pre-master course. The sample characteristics are presented in table 1. The group consisted of 6 female and 6 male students which were mostly involved in part time studies. Their mean age was 32 years (range 39) and the participants were all rather experienced with the use of mobile devices, tablet computers and 50% have even used an app-store before. Most learners were intrinsically motivated to participate in the study,

Sample Characteristics	Results
Gender	Male 50% Female 50%
Study context	75% Part time 25% Full time
Age	Mean 32.25/Range 39
Experience	85% Have experiences with using an app store 100% use a portable computer at least weekly 50% have experiences with tablet computers
Voluntariness	85% intrinsically motivated 15% extrinsically motivated

Table 1. Participants iPad study

Material & Procedures

The learners who had decided for the digital version received an Apple iPad 2 preinstalled with the standard applications and additionally the iBooks application for ePubs and the Goodreader application for PDF files. The study material consisted of 4 courses with 7 modules in total. The study material consisted of approximately 3000 pages of printed text which is shown in figure 2.

Figure 2. Study material iPad study

Some of the textbooks used in these courses are coming from academic publishers who agreed to the use of digital versions of their textbooks in the pilot. The digital versions of the study material were to a large extent a transfer of the print design to the digital version. Only one functionality has been added: In the studybooks a self-test has been integrated via a pop-up solution. Reflective questions have been asked to the learner and the answer was then presented in the popup window. Besides textbooks some workbooks and law digest collections have been added. The material has been handed out to the students at the kick-off of the pilot. Questions about handling and use of the material have been answered at this event. In addition a telephone-helpdesk has been installed for the pilot in case of later questions. Students have been explicitly asked to use the device also for other learning purposes and they were allowed to install additional applications under their own account.

Data Collection

Data collection has been done via a monthly questionnaire administered with an online questionnaire administration software. The first questionnaire has been filled out just before the kick-off-event followed by a monthly update. In January 2012 a 2-hour focus group session (Grabowski, Massey, & Wallace, 1992) has been conducted. The focus group had been prepared with an interview handbook. The focus group was conducted with a moderator and an assistant. The session has been recorded and transcribed.

RESULTS

In this part of the paper we summarize the results of questions from the monthly evaluation related to learning practices. In addition we summarize the most important findings from the focus group session in January 2012.

Monthly questionnaires

We have administered a monthly questionnaire in which we have collected responses with regards to changing learning practices. The students have been asked to evaluate statements on a 7-point-likert scale ranging from 1 (completely disagree) over 4 (neutral) to 7 (fully agree). To see how stable the effects on changing learning practices are we have repeated the evaluation of the statements each month (Pre-M4).

Question	Pre	M1	M2	M3	M4
The iPad offers new learning opportunities	5.67	6.92	6	6	5.58
The iPad connects learning contexts which have been previously unconnected	4.5	6.33	4.5	5.18	5.5
I have ubiquitous access to learning content and learning environments	5.25	6.42	5.33	5.09	5.58
I am accessing other parts of the learning environment of the University	4.33	6	4.67	4.82	4.58
In the future I am intending to use the iPad for other courses	4.42	5.67	5.25	5.45	5.5
I am using the iPad to search for information I need at a specific location	5.83	6.33	5.75	5.82	5.83
I use the iPad to search for detailed information and references	5.33	5.92	4.58	5.18	5.33
With the iPad I have flexibly more material at hand compared to print	5.92	6.67	5.58	5.73	5.67
Through the increased access to information I can reflect about alternative solutions	5.08	6.08	4.83	5.18	4.83
I am using the iPad during discussions with other students	3.83	5.25	2.67	3.36	3.08

Table 2. Mean scores for questions related to changing learning practices

Table 2 reveals some interesting findings about the acceptance and stability of effects with regards to changing learning practices. While the expectation of the students where rather neutral as depicted in the pre-questionnaire, after approx. 1 month of usage the experiences of the participants are positive to very positive. After the first month there is a decrease of values observable. In the third usage month a slight increase can be seen so that after 4 months all values show an increase compared to the pre-questionnaire and a decrease compared to the questionnaire after 1 month of usage. If we compare the questions in different categories we can see that especially the questions related to increased access to learning (Question 1-3) have been evaluated very positively and these effects are stable over time. Students are intending to use the iPad also for other courses, probably depending on the offer of the University. The students have evaluated using the tablet computer for accessing other parts of the learning environment more neutral. This could also be influenced by the usability of accessing other parts of the learning environment with mobile devices. Students seem to use the tablet computer and the learning material rather in individual learning contexts than in group learning contexts. They tend to disagree with the statement that they use the iPad in discussion with other students.

Focus group session

To enrich these results with personal accounts of the students we have conducted a focus group session in January 2012. All students in this session report newly created learning opportunities through the flexible way to carry the whole study material on the iPad. Especially in situations where a lot of changes of context is important, the digital study material is highly valued. But the use of the digital material is highly dependent on personal reading preferences and the personal learning context. Most students read the study material in different context like travel, holidays etc. and they mention the potential of using the material at any time also influences their long-term planning of learning. While the printed material is simply too much to be carried during travel the digital material adds much flexibility to the curriculum delivery. The students do not report much use of other parts of the electronic learning environment of the Open University of the Netherlands. So they seem to use the iPad rather as a reading device and they do not use the device to access the VLE of the University or other parts of the electronic learning environment.

Some students report the connectedness of the tablet-computer as a limitation since they are easily disturbed in concentration due to access to other apps they use for personal purposes (e.g. mail). Several students have visited voluntarily support lectures at the study centres of the Open University of the Netherlands. During these sessions they have faced problems of collaboration and synchronisation. The lecturer was using the printed version of the books while some students used the ePub version which has no fixed page numbers. This has lead to confusion and a mismatch between the study material used in a lecture. Students have only reported low usage of the opportunity to personalize the tablet-computer according to their own requirements. Only a few number of students report the installation of additional apps for productive work (Office apps), data sharing (Dropbox) and applications for flexible annotations. Since students of law have to combine different sources like a textbook, a studybook and a law digest most students report that it is not a good solution in terms of usability to switch between several books on the tablet-computer. This has led in some cases to the practice that the students have combined digital versions and a printed version of the law digest for example.

DISCUSSION AND CONCLUSIONS

In this short paper we have briefly summarized the results of the monthly questionnaire and the focus group session conducted in January 2012. In the study we can confirm findings by Nie, Armellini, Witthaus, & Barklamb (2011) who have reported an increase of flexibility and the emergence of new learning contexts and learning practices. The questionnaire has shown that the effects have been to date relatively stable. Nonetheless there seems to be also a novelty effect (Clark, 1983) involved although we would need to assess the data over a longer period of time to see if the values decrease even more after longer usage.

The focus group session has confirmed findings from the questionnaire and has revealed interesting details about the usage and adaptation of the device and the study material. Students have reported synchronisation problems while using the digital learning resources in lecture situations. While they have in general favoured the ePub-format over the study material in PDF-format the flexibility and use of specific reading preferences (size of text) has led to the problem that the information provided by lecturers using printed study material was not easy to follow due to the reformatting of the material according to these preferences.

The use of multiple learning resources at the same time was a common practice for the students. Especially the law digest was often used as additional resource. Students have reported a low usability in terms of switching between the digital material on the tablet computer. This has led to the practice that students have used the digital material in combination with printed resources. These findings deliver valuable input for the future development of digital learning resources at the Open University of the Netherlands and especially the School of Law. Instead of using isolated resources of the digital study material we will explore in the future the integration and intelligent linking of resources that are often used together.

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Multilingual mobile learning – A case study of four South African high schools

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ABSTRACT

The constraint of inadequate learning material and resources available to learners in some South African schools has motivated continuous attempts by the government and public to improve the education system. Most learners from poor communities rely extensively on learning material received in those schools. Language has also been identified as an obstacle in their education, as most of the South African population are not first language speakers of the instructional language. Switching between two languages (code-switching) to converse is a popular method of communication in South African schools, and this is also attributable to the country's diverse language community. A learner's inability to adequately communicate in English consequently contributes to their poor performance in schools.

The increasing accessibility of mobile phones has influenced their widespread use in various socio-economic communities as the most affordable means of basic communication and technology. This has also increased their potential as a contributory solution to the South African education challenges, as mobile phones afford learners a supplementary learning platform with limited cost implications. This paper examines the support of mobile phones to learners by the delivery of educational resources on mobile devices with bilingual content. In this research project learners were provided with low cost mobile phones and access to curriculum related bilingual learning content. Four South African public schools were subsequently assessed via surveys on the need for a multilingual mobile learning tool that enables learners to access adequate learning material in their language of choice, thus creating a pervasive learning environment.

Keywords

Multilingual, mobile learning, South Africa, high schools, pedagogy

INTRODUCTION

South African high schools are still struggling to produce desirable results in subjects such as mathematics. There are many contributing factors to the situation including a learner's inability to appropriately articulate content in the instructional language, English (Maree et al., 2006). Some of the country's schools still lack basic resources such as libraries and computers (Perumal, 2009).The rapid growth and improvement of mobile technology has yielded positive results for the delivery of educational materials, and previous research illustrates the use of wireless platforms as potential delivery methods for educational material (El-Hussein & Cronje, 2010). Mobile learning is an appropriate classification for this form of learning as "the provision of education and training on PDAs/palmtops/handhelds, smartphones and mobile phones" (Traxler, 2009:2). One of the most significant benefits of this paradigm is the support it has for ubiquitous and flexible platforms of education for learners in various learning environments (Peng et al., 2009), and mobile learning has made gradual progress as a potential learning paradigm in South African communities in areas where there are limited educational resources (Botha et al., 2008; Brown, 2008; Vosloo & Botha 2009). Mobile learning ideally permits learning which is not restricted by location and time, and it would be appropriate if the same flexibility was to be extended to the availability of learning material in more than one language (de Jong et al., 2010).

This paper explores the need for a multilingual mobile learning support in a community of four schools in South Africa. The main research question of the paper is: *How can bilingual mobile learning be used to support learners in South African schools?* Learners who participated in this research were introduced to a bilingual mobile learning tool that supports their learning process, and each element of the tool could be viewed in two South African languages, namely Setswana and English. The tool focused on supporting learners in mathematics. Whilst using the tool, learners' choice of language when accessing the content was monitored, and through a survey the learners communicated their experiences on the tool and their perspectives on multilingual mobile learning.

LITERATURE BACKGROUND

The relationship between education and language in South Africa

The legacy of the past education system in South Africa has led to problems that still affect the current education system. Resources that are considered as basic in schools elsewhere are still absent in many schools, and include adequate classrooms, libraries, computing or science laboratories and adequately skilled teachers (Perumal, 2009). One of the fundamental issues that are often overlooked as contributing to learners' poor performances is the use of language in schools, with many learners being unable to appropriately interpret and respond to tasks in English (de Wet & Wolhuter, 2009). In some rural schools, teachers conduct lessons in the commonly spoken community languages and then deliver the class notes in English, but learners often tend to find difficulties in expressing themselves in English. This situation may differ with each school's location, as in urban schools English communication is often entrusted to learners at a young age, therefore their communication and expressions should be more clear and understandable (Brock-Utne, 2007).

Moschkovich (2007), Setati and Adler (2000) investigated the reasons behind the use of more than one language by bilingual learners to solve mathematics tasks, and their research reflects existing occurrences of code-switching in mathematics lessons. They found that learners would interpret a task in their primary communication language especially if it was challenging. The learner would then attempt to communicate this using the instructional language, and this helped them better to understand what was required from them.

THE RESEARCH METHOD

A total of 90 learners aged between 16 and 18 years from four different public schools participated in the research project. The schools consisted of one located in an urban area, two located in rural areas and the final school located in a township. The participating learners were all studying mathematics in grades 11 and 12, the latter being the final year of high school in the South African educational system. Ethical issues were considered with a request submitted to the presiding department of the school to conduct research. As mobile phones are not allowed on school grounds, the learners were permitted to use mobile phones in school only for the purpose of this research, and each learner was provided with a mobile phone equipped with basic WAP features providing access to a mathematics application. The application consisted of learning material from various sources including teachers and a subject advisor from the North West department of education. Learners were given an opportunity to access a learning application with content available to view in two South African languages, Setswana and English. The content focused on supporting learners in the area of simultaneous equations, and was created to support learners between grades 10 and 12. The application had four sections of study comprising, simplified notes collaboratively created by teachers, notes from their text books, an interactive drill question and answer section, and a test in the learning area. The learners seemed to appreciate the drill section as they enjoyed receiving responses on their performance and how they could best achieve a solution. The learners went through each section at their own pace. Each page of content had an option to be viewed in either Setswana or English.

After interacting with a mathematics bilingual learning tool, learners completed self-administered questionnaires in the presence of an interviewer. The choice to be present whilst the learners filled in the questionnaires allowed the interviewer to clarify their understanding of the questions (Cohen et al., 2011). Some learners and teachers were interviewed through semi- structured interviews. This data collection process took place over a period of a month. The data were analysed through themes. Unlike other data analysis strategies, thematic analysis focuses on what the research participant's responses were as opposed to particularly focusing on how the participants responded (Bryman, 2004). Pseudonyms have been used to protect the identities of the participants.

DATA COLLECTED

Adequate learning resources

The participating learners from these three schools (schools B, C and D) depended highly on the learning content provided by the teachers as they could not afford to access more information elsewhere, while learners from school A had access to different channels of gaining further learning resources. Most of the participating learners had no knowledge of online or mobile phone based games and learning resources, and mostly came from families that had financial difficulties and could not afford to financially support their education. While 56% of the participating learners mentioned that they were at times expected to use technology to do their homework or assignments by researching on the Internet or typing out their homework, only 22% of these learners had access to a computer within the school grounds. Despite this, 48% of all learners owned a mobile phone with the remaining percentage of learners having access to mobile phones.

Language use in schools and in communities

Learners from school A also live in areas where English is the secondary popular language after the area's indigenous languages. During the research, it was found that they were able to easily articulate themselves, both verbally and in writing using the English language. Learners from schools B, C and D live in areas where their home languages are commonly spoken as the primary languages with minimal use of English in their communities. In contrast to learners in school A, some learners from these schools struggled to clearly articulate their opinions, especially when filling in the research questionnaires.

None of the participating learners had English as their first language, and learners from schools B, C, and D only acquired the skill to effectively read and write in English when they started school. Each participating learner was able to read, write and communicate in at least two South African languages including English. A total of 63% of the learners stated that they tend to code-switch between English and Setswana when asking questions during class. The code-switching occurred only verbally and not in writing. Despite the good English foundation that learners from school A possessed, most of the participating learners found that code-switching assisted them to effectively articulate their views and give answers in class. Teachers from schools A, C and D used both of these languages while teaching in order to assist learners to effectively understand what they taught. The teacher in school B was from a foreign country and primarily used English to teach as she could not communicate in other South African languages. There are different language learning books published in most of the indigenous South African languages but there are no available published books that support the teaching and learning of other subjects (i.e. mathematics, physical science) through indigenous South African languages (Setati, 2008). Learners commented on the limited availability of online learning material and resources published in indigenous languages.

Bilingual mobile learning experiences

Learners were provided with mobile phones that allowed them to access the Internet, and some of the learners used their personal mobile phones during the research project. They were given an opportunity to access and effectively interact with a mobile learning application. The application focused on mathematics (simultaneous equations), with the content available to view in both Setswana and English. The content was primarily developed to support learners in grades 10–12 providing them with resources that supported all their learning areas. The learners were able to study the subject area and also test their skills on the subject area through the application.

In the participating schools only one of the teachers, from school B, was aware of online and offline mobile learning games and the remaining teachers had no knowledge of such applications. Despite this, two of the teachers supported the learners when they raised questions related to the tasks in the content of the application and assisted them in solving some of the tasks. From interacting with the content, 61% of the learners said that they used both languages to read the content on the application. Collectively, 34% of them used only English to view the mobile content, but 98% of the learners cited the need for mobile content that supported their current studies. Although the research project was a pilot project, both learners and teachers urged the need for an extension of the project so that it could continue to support the learners. The schools situated in the urban areas (schools A and B) had the highest number of learners reading content using only the English language with 53.8% and 26.9% respectively. The school (C) with the highest number of learners reading content in both Setswana and English with 52.4% was based in a rural village. None of the learners read the content using only the Setswana language.

DISCUSSION

The information above suggests that learners still face a shortage of and a need for adequate learning material. Despite having access to learning resources, learners in school A (urban area) felt that learners need pervasive learning material to learn as and when they felt a need. For the learners in schools B, C and D, mobile learning provided a resource to support their needs. Learners especially in rural schools are still in need of supplementary learning material which they would not need to spend extra money to obtain, and this problem is more prevalent in schools situated in lower income areas. The availability of additional resources enhances the performance of learners (Legotlo et al., 2002). With most adults in rural communities either unemployed or employed as domestic workers, gardeners and other low-income related jobs, the learners' parents often struggle to provide them with basic necessities of life. Activities or resources in schools that require them to financially spend on their education become difficult for these communities to support. Furthermore the schools which they attend offer limited resources with a common shortage of teachers in key learning areas such as mathematics and science. The teachers are also faced with high ratios of learners and limited teaching resources including prescribed books per learner (DOBE, 2011). Rural based schools are often far from the main cities limiting learners on access to public libraries or Internet and computing centres. With the abundant availability of mobile phones in South African communities (Vosloo & Botha, 2009), mobile learning provides a suitable platform to bridge the existing resource divide amongst learners. Learners in these areas are often less exposed to opportunities that could support them throughout their learning process.

Language is a current challenge in the South African education system. The participating learners found it easier to mix languages when learning and to also communicate amongst themselves in the formal class settings regardless of their language background. Bilingual learning is a common factor in these schools. Prior language acquisition also affects the understanding of a learner when interpreting content. Technical aspects of the language need to be clearly understood by a learner beforehand in order for them to adequately understand and respond appropriately to their tasks in class. This problem seems to be prevalent in mathematics classrooms. Mathematics needs to be clearly communicated through language in order for the learner to clearly understand what is required of them and to consequently respond appropriately (Botes & Mji, 2010; Setati, 2008). Some of the factors leading to poor language acquisition include the learner's "lack of English reading material at home and at school; and poor language teaching by teachers whose own English proficiency is limited" (Nel & Muller, 2010: 636). There is also a lack of learning material available in most South African languages for secondary school mathematics lessons (Setati, 2008). The classrooms are thus characterised by learners and teachers who cannot communicate adequately in English and do not have sufficient access to learning material available in their home languages and the instructional language.

CONCLUSION

Many researchers have outlined the potential use of mobile phones as learning resources. Having learning content available on mobile phones increases the ease of access to learning material for learners in different communities. From the research results, there is a clear limitation on the amount of learning resources that are available in multiple South African languages. With educational policies and dialogue supporting the need for multi-language classrooms there is a need for learning material that will support this. The permutation of mobile learning and multilingual content needs to be further explored to improve the current state of education and language use in South African schools and afford learners ubiquitous learning content in their preferred language of choice.

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Smartphones in vocational tourism education: Truly useful or just another reason to find new excuses

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ABSTRACT
This article describes a longitudinal study of vocational tourism students' perceptions of the use of smartphones before and after being given the devices. Data includes interviews and online learning diary data from a period of about 18 months (N=14). By providing smartphones for these extremely mobile students, the researchers mainly aspired to promote possibilities to reflect their learning and to improve communication between students and their instructors during their apprenticeship periods. The use of smartphones instead of laptops was an extra option, and not a necessity. Results show that despite quite positive expectations and first experiences, students' positive attitudes faded during the study. Most students did not take full advantage of the devices provided, and instead used them in quite a conventional way. Only a few students used their phones innovatively to help them with their work tasks during their apprenticeship periods.

Author Keywords

Smartphones, ubiquitous, mobile learning, contextual, vocational, tourism education

INTRODUCTION

Mobile learning has received considerable attention in recent years, as mobile technologies become more common and new devices become available each year with more capabilities, better and bigger screens, more capable hardware, faster browsers, etc. As smartphones are still quite new in the context of education, there are only a limited number of longitudinal studies in which the use of smartphones has been followed for a longer period of time. Looi et al. (2011) studied a class taking mobilised lessons over a period of two years, but such studies are otherwise scarce. Wu et al. (2012) reviewed mobile learning studies made between 2003 and 2010 and found that 86% of the studies resulted in positive outcomes for learning. The problem with earlier research concerning mobile devices and applications has been, in many cases, the fact that most of the experiments have involved the "WOW effect" – testing something new and exciting that most probably also has a positive effect on student motivation – at least in short-term experiments. Therefore, there is a need for studies in which the use of these technologies is followed for a longer period of time. Only longitudinal studies would show whether mobile technologies themselves still have a positive effect on learning after the "WOW effect" has disappeared.

The research setting of this study is a vocational tourism education program that has been physically moved to a ski resort 50 km from the main campus of the hosting vocational college (cf. Vuojärvi et al., 2011). The students in this program are extremely mobile, as a large part of their studies are located outside classrooms and one-third of their two-year degree programme consists of apprenticeship periods in tourism companies around Finland. Therefore, even without mobile devices, their learning would be truly mobile; mobile devices could simply make many tasks and communication outside classroom much easier. The definition of mobile learning by Pimmer et al. (2010) fits well with the situations and contexts these students face in their studies: "*the process of coming to know and of being able to operate successfully in, and across, new and ever changing contexts with and through the use of mobile devices*" (p. 2).

This paper presents a longitudinal study where students had the possibility to use smartphones for a period of about 15 months. Student perceptions about these devices were recorded through interviews in four phases, both before and after receiving the devices. The reason for providing students with smartphones was to make it easy for the students to reflect on their learning through online diaries, and to promote their communication with their peers and instructors during their apprenticeship periods. Like Looi et al. (2011) we are also interested in exploring the ways in which students take responsibility and ownership of their mobile devices and learning. Sha, Looi, Chen and Zhang (2011) state that learning with mobile devices "*involves more than technological or pedagogical considerations, and learner characteristics such as motivation and abilities in monitoring and controlling one's learning in different settings need also to be considered*" (p.2).

The research questions of this study were as follows: 1) How do student perceptions of smartphones as learning tools change as they get more experience in using them? 2) Does the possibility to use smartphones increase students' posting frequency in their online learning diaries?

DATA COLLECTION AND ANALYSIS METHODS

The data for this study was collected during a period of about 18 months beginning in the autumn of 2010 and continuing until late spring of 2012. The data in this study consists of student interviews collected in four phases from a total of 14 students (N=14, 13, 9, 12), as well as the online learning diaries (N=14) the students wrote during their apprenticeship periods at various tourism companies. The first two interviews included questions about students' attitudes towards the use of various technologies, including mobile tools, during their studies. The last two interviews included questions about students' real experiences of using smartphones in their studies and during their free time. The smartphones provided for students were quite basic (Nokia C6), with physical keyboards, and WLAN and 3G-connectivity. If students had their own smartphone, they were free to choose which one to use during their studies.

During their apprenticeship periods, also before receiving their smartphones, students were expected to write online learning diaries (WordPress blogs) where their assignment was to describe their tasks and duties at work, reflect on what they have learned and whether they have succeeded in achieving the goals set before the period started. The blog enabled their teacher to follow their work and developments at work, comment on their reflections, give guidance and otherwise communicate with individual students. All students were asked for informed consent (cf. Sieber, 1992) for the researchers to read their diaries, conduct interviews and use them as research data. All data were analysed using qualitative content analysis (Gray, 2004).

RESULTS AND DISCUSSION

Students' expectations towards the use of educational technologies were overall very positive during the first interviews in autumn 2010. More than half of the students (8/14) indicated that they were eagerly awaiting the chance to try different digital learning environments and mobile devices. Some were considering the devices' potentially positive effects on studying, some were interested in the technologies in general and some were especially hoping that mobile devices could make their learning processes easier.

"For example, I haven't ever had a phone that could be used for reading emails. It might activate students if you could be reached even when you are arranging activities for some group [outdoors]"

None of the 14 students interviewed had negative expectations towards educational or mobile technologies. For those who had neither positive nor negative expectations (6/14), the doubts stemmed mostly from the students' own uncertainty with technologies.

"I'm so helpless with all those devices that I don't know what will happen […] I suppose they might [help] or I don't know"

Even before the students were given the smartphones, they were expected to reflect on their learning during apprenticeship periods in their online learning diaries. In an earlier study, students indicated that their low writing activity was because of a lack of Internet connections and/or the exhaustion after their long working days (Vuojärvi, Eriksson & Ruokamo, 2011). In most cases, however, students felt that they had various breaks and even time that they spent just waiting for customers – time that could possibly be used for study-related tasks. Therefore, smartphones were provided for students as tools that could help them update their blogs, communicate with peers and instructors, and provide a means for different modes of note-taking (pictures, videos or voice recordings), even "in the field". At least with smartphones, there should not be any more of the above-mentioned excuses for low writing activity.

Before receiving smartphones, students were questioned about the expected effects on their diary writing activity. Most (10/12) students thought that a smartphone would probably make updating their learning diaries easier. Some students also thought that smartphones would help in using their breaks more effectively, as they could easily make short notes of their work or take pictures of their projects with their smartphones, which would always be with them. Smartphones and 3G-networks would also solve the problem of insufficient Internet connections.

"I actually did have such times that there might have been even an hour when my job was just to wait – so in principle you could write – I certainly didn't have my laptop with me"

Only three students questioned the benefits of smartphones. Two students indicated that they would rather write their blog posts with a laptop. One student noted that the writing activity does not necessarily increase unless students apply themselves to the task.

When smartphones were handed over to students, it was made clear that they were free to choose which tools they would use for the tasks given by their instructor. Students were instructed on how the new smartphones work, and some basic applications were installed on each phone in order to ensure that less tech-savvy students also got an easy start with their phones. Support was available from the researchers if problems with the devices arose later. Once equipped with their smartphones, students' first task was a course on tourism product knowledge, in which their job was to plan, record and edit tourism-related videos (Eriksson, Tuomi & Vuojärvi, accepted). Therefore, students already had experience with their particular smartphones when they headed to the next apprenticeship period.

After the first two apprenticeship periods with smartphones, the students were asked about the pros and cons of their smartphones. The experiences were very positive and most of the nine students interviewed in spring 2011 indicated that the phones had been very useful.

“It was handy to use the [wireless] network at the workplace and to write and even to take some pictures”

“It seriously benefited me – there wasn’t an Internet connection in [name of the ski resort] so I wrote part of my blog posts with the phone”

Even though some students had a few technical problems with their phones, they still were quite satisfied with their devices. Only two interviewees commented on the usability of the devices with a slightly negative tone.

“It might be useful – at least nothing negative comes to my mind”

“At least I can’t think of that many unsatisfactory issues”

Students used their smartphones mainly for web browsing, blogging, checking their email and taking pictures. Only three students – all men, working mostly outdoors and out of the reach of WLAN connections – seemed to actually take advantage of their smartphones’ capabilities during their apprenticeship period. They used their phones, for example, to inform their customers about weather forecasts or train timetables, to help communicate with foreign customers through the use of a dictionary application, or simply by making notes with the phone. Overall, it seemed that the period of about three months did not actually help these students, of which only one had owned a smartphone beforehand, to really take advantage of the capabilities the smartphones could offer. One woman stated this observation quite well:

“Just for basic stuff [phone calls and text messaging] and browsing the Internet […] taking pictures. […]I haven’t needed a phone like that earlier so I can’t use it for anything else then just for the basic stuff.”

Less than half of the students interviewed used their phones to write new posts to their online diaries and there was no trend that would have indicated more active posting to students’ blogs. The reasons for not writing were generally the same than before - with the exception that no one complained about the lack of Internet connectivity. One student gave the excuse that the blogging application in their smartphone was not working; however, students were also informed of the possibility to post updates to their blogs through email.

The last interviews were conducted after the students had already used their smartphones for a full year, in February 2012. There was not much change in the use of smartphones, and some students had even bought new and more advanced devices. When specifically asked about the educational use of smartphones it became clear that, in their experience, they did not use their phones very much in their studies. It seemed that some students thought that educational use includes only blogging and making videos; namely, activities that have been part of a previous assignment.

“Well, I don’t know – there are just those couple functions or so – video recording and writing the blog”

“No – not actually. Those phones were provided for us so that we can write those blogs but I haven’t written it at all [with a smartphone].”

Only a few students mentioned using email or communication through social media sites. Those that actively took advantage of the email application indicated that it was one of the best features that smartphones have, as it genuinely makes their communication more effective. Researchers expected that students would invent many innovative uses for their smartphones, but only one or two of the students actually lived up to these expectations.

“I took some pictures, then I used it quite a lot for information searching […]. During the apprenticeship period, working as a guide, I used a dictionary quite a lot and then one could show pictures [from the Internet] if someone had, for example, found some animal tracks – then I could show a picture of the animal – what does it look like and so on.”

Although the idea of blogging using smartphones, e.g. during lunch or other breaks, seemed like a functional solution before and shortly after receiving smartphones, even for the students themselves, the reality was different. Students seemed to have problems motivating themselves to reflect upon their learning in their learning diaries. Many students just wrote one or two blog posts and/or a summary of their apprenticeship period. Some students also said that writing with the phone was not as handy as they first thought, and that they had problems with the blogging application. However, some of the students did use their smartphones for blogging and the blog posts could also have been sent through email. In the end, the results were probably mostly due to the student’s self-regulative skills, motivation and perhaps also their ability to reflect on their learning. As Vogel, Kennedy and Kwok (2009) wrote: ”*we can provide our students with a range of technological support and mobile device applications but this will not ensure learning*” (p. 483). Results of this study are supported by those of Vogel et al. (2009), who claimed that to engage and sustain students to apply mobile devices in learning, they should have an appreciation of deep learning as well as time management skills. Motivation also plays a key role in this equation.

CONCLUSIONS

Although mobile learning clearly provides possibilities for both formal and informal learning, the informal activities in particular demand quite a lot from the students themselves. Taking advantage of mobile devices and making use of, for example, the breaks in between work tasks, seems to require self-regulating and motivated individuals that are willing to put some effort into their learning. Therefore, the provision of students with mobile devices does not necessarily have any measurable effects, at least in situations where their use is largely informal and not strictly controlled and directed by the instructor.

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Educational Accelerometer Games for Computer Science

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ABSTRACT

Algorithm visualizations have been used a lot in computer science to help students understand abstract concepts such as data structures and algorithms (DSA). The most widely used algorithm visualization systems are all based on Java and, alas, are not usable on mobile devices. We tackled this problem by designing a set of assignments for mobile learning of an important concept in DSA, namely binary trees. To make the assignments more motivational and gameful, they use the accelerometer data for simulating the behavior of the algorithm in question. This paper introduces the prototype we built as well as discusses the pros and cons of such assignments.

Author Keywords

Accelerometer, mobile, engagement, mobile learning, algorithm visualization, serious games, gamification

INTRODUCTION

In computer science, learning abstract concepts such as data structures and algorithms has been generally considered difficult for students. This has led to the development of a multitude of algorithm visualization (AV) systems designed to aid students in understanding such abstract concepts. The most well known systems include Animal (Rößling and Freisleben, 2002), JHAVÉ (Naps, 2005), ViLLE (Laakso et al., 2008), and TRAKLA2 (Malmi et al., 2004). The extensive research on educational use of these and other AV systems has come to the conclusion that to be educationally effective, learning materials need to be interactive (Hundhausen et al., 2002; Naps et al., 2003).

The current breed of systems has problems, though. Most of the systems are implemented in Java (Shaffer et al., 2010). With the recent rise of use of mobile devices for web usage in general and for online learning in specific, the existing solutions are not applicable. This has led to research into bringing algorithm visualization to mobile devices (Karavirta, 2011).

Modern mobile devices include growing number of accurate sensors enabling applications to take advantage of information such as location and movement of the device (Lane et al., 2010). This progress has been also a significant boost for mobile serious games, where the aim is to learn useful things while playing. Good examples of uses of mobile sensors for games are accelerometer in MotionMath[1], geolocation in MobileGame (Schwabe and Göth, 2005), and cameras in Art of Defence (Huynh et al., 2009)

The mentioned problems with existing AV systems on mobiles, advance of mobile sensing as well as the rise of serious games is the motivation for us to pursue the use of accelerometer information. In this work in progress paper, we present a prototype of assignments for data structures and algorithms that take advantage of the accelerometers in mobile devices. The prototype presented in Section 3 includes assignments for tree structures where students simulate the behavior of an algorithm by guiding a ball through the tree data structure.

BACKGROUND

Interaction has been hypothesized to be the key to educational effectiveness of algorithm visualization. The Engagement Taxonomy summarizes this to five active levels of engagement of the learner with a visualization (Naps et al., 2003). The engagement levels range from passive *viewing* of a movie-like visualization to student *creating* and *presenting* visualizations to others.

Our previous work, a system called TRAKLA2 (Malmi et al., 2004), includes assignments where students simulate actual algorithms by manipulating data structure visualizations (thus, engagement level *changing* since they are changing the existing visualization). The system has a growing set of assignments, currently around 50. However, the assignments are implemented as Java applets, and do not work on mobile devices. Our main motivation was to improve these and explore new possibilities of mobile sensor data at the same time.

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[1] http://motionmathgames.com/motion-math/

[2] http://www.bythemark.com/products/quiz-learn-python/

Mobile learning has become a hugely popular field of research. According to a recent literature review, computer science is one of the disciplines where mobile learning is used the most (Wu et al., 2012). One such example is Quiz&Learn Python[2], which is a mobile quiz game for learning Python programming. It also includes visualizations of program code behavior. We are not aware of research in CS that would use accelerometer in learning. In general, accelerometer data has seen different uses since supported by mobile devices. Imaginative examples include using it for text input in chat on a wristwatch (Partridge et al., 2002) and enabling vision-impaired to play and interact with others by moving the device to give commands (Mehigan, 2009). A popular category for application has been acceleration based games (Chehimi and Coulton, 2008; Baek and Yun, 2008). In educational games, acceleration is used in MotionMath for learning fractions.

In general, playing computer games is often considered to be engaging and motivating. Shabanah et al. (2010) propose that playing computer games can combine all five active levels of the Engagement Taxonomy. The vast popularity of games combined with the increasing number of mobile devices offer a huge potential that could be harvested with well-designed games that also teach the players. Serious games tackle that challenge. They are games whose primary goal is education, rather than entertainment (Michael and Chen, 2006). Optimally, serious games make use of the engaging features of recreational games, while including educational goals in the gameplay. Another approach for making assignments more motivating is to use methods of gamification. Deterding et al. (2011) define gamification as: *"the use of game design elements in non-game contexts"*. However, the line between serious games and gamified applications is not always clear.

ACCELEROMETER FOR INTERACTIVE BINARY TREE ASSIGNMENTS

Our interactive assignments[3] deal with binary trees and binary search trees (BST), both of which are important concepts in data structures and algorithms used in, for example, in many built-in libraries of programming languages for storing and retrieving key-value pairs as well as for sorting data. They also provide a good opportunity to use accelerometer data since the algorithms have the concept of "visiting" the nodes. That is, the algorithm does something to the current node, left child, and right child in some order decided by the algorithm (typically based on the input).

Figure 1 shows an example of one such assignment in progress. The main idea is to guide the ball by tilting the device. The ball needs to be guided through the nodes in the order that the actual algorithm would visit them. In the case of in-order tree traversal shown in the figure, the algorithm will first visit the left child, then the root, and lastly the right child.

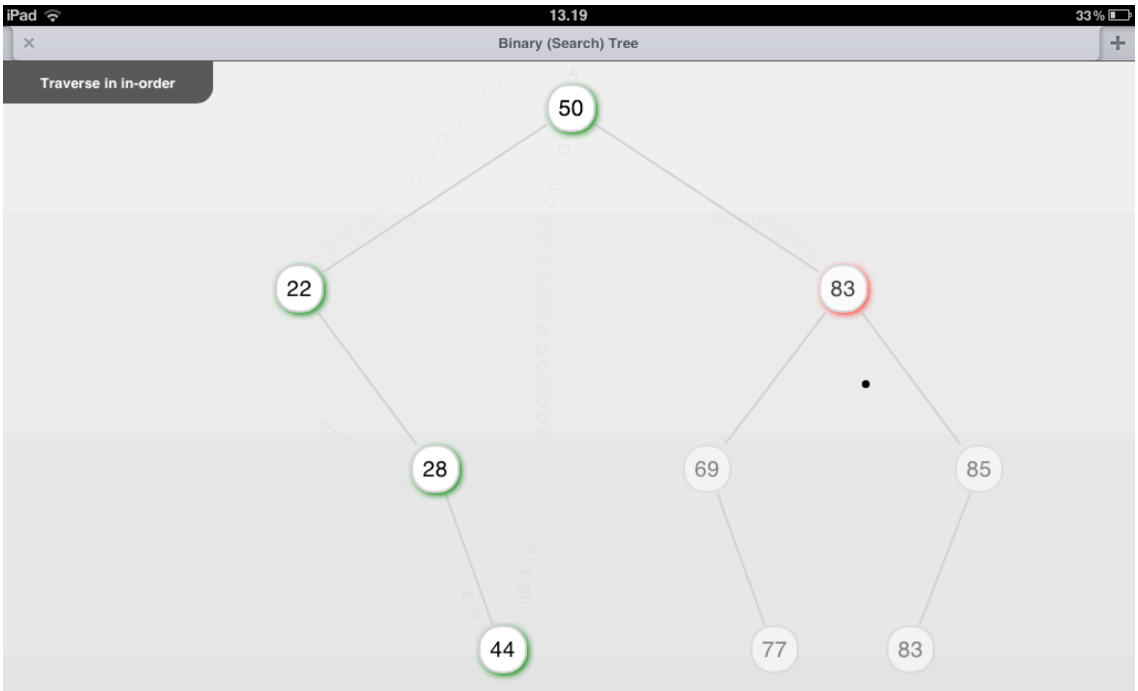

Figure 1: The assignment is solved by guiding the ball (below node 83) in the tree. Green highlight (nodes 50, 22, 28, and 44) is used to indicate correct steps whereas red (node 83) indicates incorrect step.

The exercises have some features that make them pedagogically more useful. First, the assignment can be tried as many times as the student likes. On each try, a new randomized input (that is, randomized tree) is generated to make solving it

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[2] http://www.bythemark.com/products/quiz-learn-python/

[3] Currently a set of five assignments.

again more meaningful. The student also gets immediate feedback on each step. This is indicated by the green and red highlights of correct and incorrect steps, respectively. Solving of the assignment can always be continued after an incorrect step. To track student progress, each assignment keeps a record of how many times the student has tried to solve it and how many times it was correctly solved. While assignments in our existing TRAKLA2 environment give points to the course fulfillment, the accelerometer assignments record the fastest time the student solved the assignment. A design choice was not to have the chance to pause the assignment. We argue that this makes it more hectic and does not give time to think.

While we see the concept important, we want to briefly touch on the technology used. The assignments are implemented using HTML5 and JavaScript, using the W3C Device Orientation Event specification[4] and SVG (Scalable Vector Graphics) for drawing the graphics. This makes it platform independent instead of choosing some native application platform. However, to be able to use the assignments without a network connection, we have also made a native application for Apple iOS.

DISCUSSION

One could argue that using accelerometer to select the nodes of a binary tree is just a more difficult way to complete the task than clicking them. Also, using accelerometer instead of clicking is likely to increase the time needed to complete the task. This can be demotivating especially if the assignment is a compulsory part of a course. However, the challenge of traversing the tree by tilting the device could also increase the motivation and engagement towards the assignment. McGonigal (2011) states that rules that limit players' allowed actions are one of the four defining traits that all games share, along with: a goal, a feedback system, and voluntary participation. The use of accelerometer to navigate instead of clicking the nodes can be seen as a rule that limits players' allowed actions. In a similar way, for example, golfers have agreed to follow a set of rules that limit their actions of moving the ball to move it only by using a golf club. In our opinion, using accelerometer could be one way to make the exercises more gameful and engaging by adding the limitation of navigating the binary tree only by tilting the device.

Using accelerometer is one step towards game-like assignments, but there are also several other possibilities that could be done in order to make these assignments more gameful. Garris et al. (2002) provide a categorization of game elements that differs slightly from McGonigal's traits of games. They say that the six key dimensions that characterize games are: fantasy, rules/goals, sensory stimuli, challenge, mystery, and control. By taking these elements into account, we could gamify our assignments further. More appealing graphics could be introduced to improve the sensory stimuli of the assignments and a background story could be used to add fantasy element in order to draw the attention of the players. For example, in case of the binary search tree search, the goal of the game could be to guide a parachutist from the top of the screen to the correct landing pad following the rules of the BST search algorithm. Also, increasingly difficult levels could be used to offer suitable challenges for different players.

In addition to thinking the gameful aspects, the scope of game-like assignments using accelerometer could be widened. Binary search tree and tree traversals are rather simple topics, meaning that mental processing required for one step in the algorithm is not complex. Thus, the continuous control of the device does not make solving of the problem too hard. However, in more complex algorithms, this should be addressed in the design of the assignment.

As for the role of such assignments on a course, we like the approach of having them as optional material supporting the learning of course content. Naturally, the other option to use these assignments would be to use them as a required or alternate way to get points for a part of a course. However, as we believe mobility and the use of accelerometer is more motivational for students, we like to keep these as voluntary learning objects. This approach is also supported by one of McGonigal's traits of games. It should be noted, that this does not mean that they could not be used to get credits on a course.

Finally, when compared with the existing AV systems, the engagement in our approach is different and does not directly fit any of the existing categories of the engagement taxonomy. Thus, the educational effectiveness of these assignments is something we will research in the future evaluation of the system.

SUMMARY

In this paper, we have introduced a set of assignments for data structures and algorithms that use the accelerometer data for student engagement. We have also discussed pros and cons of such assignments as well as provided possible future directions. Concrete future steps we want to take include usage with students on a course. This will be done as an additional way for students to learn instead of giving points for it, for the reasons discussed above. Moreover, we will diversify the selection of assignments. Finally, we are encouraged by the good examples of educational games using different mobile sensors. Thus, we will explore new ways to bring these sensors into CS education in more game-like ways.

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[4] http://dev.w3.org/geo/api/spec-source-orientation.html

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Investigating learner interactions via ubiquitous access

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ABSTRACT
This short paper is an account of the first steps in a research into how does mobile accessibility impacts the learner interactions (social versus cognitive presence) of adult learners in an informal, open, online course. The research is set up as a mixed methods study, combining two types of new educational learning/teaching formats to investigate a possible diversification in learner interaction. The two learning/teaching formats are: 1) the open, online course which embeds social media as a way to enhance peer-to-peer interactions, specifically the Massive Open Online Course (MOOC) format, and 2) mobile learning (mLearning). The reason for combining these two contemporary educational approaches is to investigate whether or not learner interaction is impacted by enabling mobile access to a MOOC. The learner interactions will be investigated making use of an adapted Community of Inquiry (CoI) framework which focuses on learner interactions. The learner interactions under investigation using the CoI will be: social presence (personal interactions between course participants) and cognitive presence (cognitive, academic or intellectual interactions between participants). This short paper provides an overview of the research problem, its background, a shortened literature review and the methodology used. During mLearn2012 the research will have reached a first analysis and these first analysis will be shared by the participants of mLearn2012.

Author Keywords
Mobile learning, mLearning, mobile devices, Community of Inquiry, open education, collaborative learning, learner interactions

INTRODUCTION
Since 2005 the worldwide rise of mobile devices, social media and learning that is facilitated by new mobile and social technologies, has grown exponentially (Johnson et al., 2010). With the recent rise of new educational forms (both instructional and technologically) new research is emerging to study the impact and dynamics of these new technologies and ways of instruction. de Waard et al. (2011a) indicated that combining technologies that embrace the complexity of knowledge production with pedagogical formats that allow learners to build knowledge by means of filtering that complexity, will allow a new educational balance to emerge. In this case the CoI framework will be used to analyze part of the complex learner interactions taking place in a contemporary, new ubiquitous learning environment.

PROBLEM
What happens to learner interactions if an already social media rich massive, open, online course (MOOC) is made accessible to mobile devices for the purpose of mobile learning (mLearning)? Will there be a diversification in the learner interactions that take place based upon the fact that part of the learner group uses mobile devices to access the course? How do these interactions relate to each other while using the Community of Inquiry (CoI) framework? Is the fact that the open, online course embeds social media the real impacting factor on increased/decreased learner actions?

This research will look for well-founded answers to these questions.

PURPOSE AND SIGNIFICANCE OF THE RESEARCH
The purpose of this sequential explanatory mixed methods study will be to come to a grounded theory on how mobile devices access does or does not increase learning interactions in an open, online course environment that is social media rich. As such the focus will not be on the affordances of adding mobile accessibility to the course which has been researched before, but will look at learner participation in the course: dialogue, collaboration, informal learning and networking, communication with social media tools. As learner interactions are at the core of this research, this study looks into collaborative learning. 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 as described by de Waard et al. (2011 b). MOOCs lend itself for research in many areas, including research in the areas of learner motivation, engagement, social presence and instructor presence (Koutropoulos et al., 2012).

The main significance of this study lies in the fact that no existing studies have explored the learner interactions of adult learners that access open, online course resources, activities and dynamics with mobile devices compared to adult learners that do not make use of mobile devices to access a social media enhanced course. Knowledge and understanding of the factors affecting learner participation in ubiquitous learning environments may provide additional insight into ubiquitous, open, online design to create an optimal learner course environment. Knowing the impact of ubiquity on mobile and non-mobile learner participation, can also result in guidelines for adult learners to increase their success rate for completing such courses. It might also be able to reduce the drop-out rate for these type of online courses.

THEORETICAL FOUNDATION THROUGH LITERATURE

While looking for a possible research subject, a literature search was done to get an idea of contemporary challenges with regard to mobile learning and learning aspects. This resulted in a set of challenges put forward by a number of mLearning and Community of Inquiry (CoI) researchers that are relevant to the study at hand.

mLearning challenges

Peng (2009) indicated the need for researchers "to conduct research on the effects of ubiquitous computing" (p. 11). However this challenge covered too much ground. Gill Clough (2009) focused on informal learning and based on her research she concluded that "future research into mobile learning needs to take account of the role of mobile technology in supporting collaborative and constructivist learning over a wider geographical and social context" (p. 131). Her focus on a wider geographical and social context can relate to the MOOC format as these types of courses have attracted and will attract a global audience with a diverse professional and personal background (Fini, 2009).

Kukulska Hulme et al. (2009) stated that "research attention should be directed at identifying those simple things that technology does extremely and uniquely well" (p. 9) and they cited Roschelle (2003) adding that it is equally important "to understand the social practices by which those new affordances become powerful educational interventions" (p.268). In addition Kukulska-Hulme et al. mentioned that "moving the focus away from the mobile technology and towards the social practice it enables, allows for a different conceptualization of mobile learning" (p. 9) and they concluded saying that researchers in mobile and ubiquitous learning will be keen to tackle the new challenges arising from learner activity across multiple virtual and physical contexts, spanning formal and informal learning.

Looi et al. (2010) brought learner curiosity and social spaces together when he mentioned that "the challenge is to enable learners to learn whenever they are curious and seamlessly switch between different contexts, such as between formal and informal contexts and between individual and social learning, and by extending the social spaces in which learners interact with each other" (p. 1). Hence, it will be interesting to look at an informal learning environment that allows different social learner interactions to take place.

Frohberg et al. (2009) screened 1469 publications (570 papers of mobile learning conferences and 887 papers of journals) and categorized 102 mobile projects that were happening up to 2007. They came to the conclusion that "although a significant number of [mobile] projects have ventured to incorporate the physical context into the learning experience, few projects include a socializing context" (p. 1) and they went on stating that "despite the fact that mobile phones initially started as a communication device, communication and collaboration play a surprisingly small role in Mobile Learning projects" (p. 1).

The fact that experienced adult learners would be the target population of the study, also had an added bonus when looking at mobile projects from the past. Frohberg et al. (2009) concluded that "there is hardly any conventional support for learners that have already reached a trained level and who want to advance. In their continuously evolving context, they have a lack of means and instruments to reflect and process their knowledge, to record and share their insights with others who are not physically present, and to create material to work with in a self-reflecting or cooperative process. To position Mobile Learning in this niche would facilitate an innovative learning support that was not possible before and thus establish an immediate value" (p. 16).

CoI challenges

Next to the challenges put forward by mLearning researchers, there is also research to be done in the realm of the Community of Inquiry (CoI) framework. The CoI is of interest to analyse and interpret learner interactions, as such the CoI will be used for the purpose of qualitative data analysis in this research for it enables learner interactions that populate qualitative data to be meaningfully analyzed according to the type of interaction taking place. The CoI framework is a process model that provides a comprehensive theoretical model that can inform research on online learning. It assumes that effective online learning requires the development of a community (Rovai, 2002; Thompson & MacDonald, 2005; Shea, 2006) that supports meaningful inquiry and deep learning. Specifically with regard to online interactions that relate to the cognitive presence Swan et al. (2008) mentioned a research gap: "cognitive presence may be the least researched and understood of the three presences [covered by the CoI], yet it is cognitive presence that goes to the heart of a community of inquiry" (p. 5). Part of the analysis done in this research will look at both social and cognitive interactions undertaken by course participants that do and do not use mobile devices to interact in an open, online course. This analysis is part of phase 1 and will also be investigated further during phase 2.

Given all these research challenges and suggestions, it is the researcher's belief that this study will add to the overall knowledge of the distance education field.

METHODOLOGY

This study will use a sequential explanatory mixed methods design, which is a procedure for collecting, analyzing and "mixing" both quantitative and qualitative data at some stage of the research process within a single study, to understand a research problem more completely (Creswell, 2009).

Research environment

MobiMOOC2012 (http://mobimooc.wikispaces.com/) will be a mobile accessible MOOC focusing on the topic of mLearning that will last for three weeks with a tree like course sequence (i.e. first week only one module, second week three modules, and during the third week participants will be able to choose between six mLearning topics to focus on). The course will be running from 8September until 30 September 2012. The format of the course is an adapted design derived from the Massive Open Online Course or MOOC format. This format uses a lot of social media tools and has a big focus on peer-to-peer participation and collaboration.

The amount of participants entering the course is not known, as the course is open to all and the free registration has only started in mid April 2012. Looking at the previously organized MobiMOOC2011, a population of approximately 500 participants can be expected.

Target population

The population of this study is delimited to the participants of MobiMOOC2012. The researcher of this study hopes to be able to identify a total study population of between 60 – 80 learners (depending on the amount of participants willing to sign up for the research via the consent form) for the first quantitative phase of the study, divided over two groups:

- MobiMOOC participants that will use mobile devices to access and interact with other participants during the course.
- MobiMOOC participants that will not be using mobile devices to access or interact with materials or other participants during the course. These participants will be using a fixed computer or laptop with an internet connection to connect to the course locations.

The assignment of MobiMOOC participants to either the mobile device using group, or the not-mobile device using group will be done on basis of the mobile device definition used for the purpose of this research. In order to divide the sample group into two groups, an indicative question will be put into the survey that will allow the researcher to set-up a mobile and a non-mobile sample group for both phases of the research. If Ethics approval is gotten in time, the sample population for this study will be approached two weeks prior to the beginning of the course (i.e. 27 August 2012) with a request to be part of the research at hand. This request for participation will be sent as a general announcement to the complete MobiMOOC participant group, with a clear link to the research consent form that accompanies this research study and a request to return the consent form before the actual start of the course.

Research design

This study will use a sequential explanatory mixed methods design. In a first phase statistical, quantitative results will be collected from surveying a sample of the MobiMOOC participants (divided in two groups, one group that will use mobile devices to access and interact with the course, and the second group who will not be using mobile devices to interact or connect to the course). In addition to the survey an analysis of the interaction frequency of both target groups will be conducted. After this first phase the second phase will start with 20 - 24 purposefully selected individuals that will be interviewed related to their learning interactions in order to come to a grounded theory on the impact of mobile device access on learning interactions in an informal, open, online course.

RESEARCH RESULTS SHARED AT MLEARN2012

At the time of mLearn2012 the first set of data will have been analysed and ready to be shared with an academic audience. The results will give an overview of the qualitative data and the differentiation of learner interactions following the CoI. The qualitative data shared will reflect potential differences in learner interactions for learners using mobile devices for learners and participants who do not engage in the course with mobile devices.

CONCLUSION

The first steps in the search for the potential impact of mobile accessibility on learner interactions in an open, online course will be of interest to the mLearning community, as it focuses on the currently less researched area of social interactions in a mobile learning environment. As the researcher highly values the thoughts and ideas of peer mLearning researchers and mLearning experts, it will add to the overall research when the first results of the study will be shared and commented by the participants of mLearn2012. In addition the first findings will enable researchers focusing on similar areas to add to their research, or exchange notes on the subject.

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Bridging Digital Divides in the Learning Process: Challenges and Implications of Integrating ICTs

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ABSTRACT

This paper investigates an initiative by a New Zealand School to integrate one-to-one ICTs into the learning process, called 'bring your own device' (BYOD). Prior to embarking on the BYOD initiative, similar past initiatives have been studied and some persistent issues have been identified. Before starting with the detailed investigation of BYOD, a preliminary analysis of the public response data from different sources has also been conducted. From the past initiatives and preliminary analysis of public responses, we have been able to form general research questions for the study. A socio-cultural ecological approach to mobile learning has been considered appropriate as a means of analysis for this study.

Author Keywords

ICT integration, learning outcomes, digital divide, one to one digital devices

ANALYSIS OF PREVIOUS ICT INTEGRATION INITIATIVES IN NEW ZEALAND

Recent trends in education emphasize the integration of information and communication technologies (ICTs) to the existing pedagogy to transform the learning process. The introduction of ICTs provides potentially valuable resources for learners' academic and social development (Demiraslan & Usluel, 2008). However, previous digital opportunities projects in New Zealand indicated that ICT integration into the learning process might end up contributing nothing more than just an effort to facilitate material access to ICTs (Rivers & Rivers, 2004).

The Digital Opportunities Project was an initiative by the New Zealand government in collaboration with participating schools and associated businesses. This model was the combination of four different projects conducted in different parts of the country. The digital opportunities projects were first implemented during the 2002 and 2003 academic years. The aim of these projects was to assist in bridging the digital divide in low decile schools (i.e. schools in areas of low socio-economic status) by providing (a) material access to ICTs for students and teachers (b) professional development training for teachers, and (c) infrastructure to promote collaboration between teachers and students from different schools. However, despite very good strategy and infrastructural support, evaluation of the digital opportunity model and its four different projects showed that the overall goal of bridging the digital divide was not achieved (Parr & Ward, 2004; Rivers & Rivers, 2004; Winter, 2004).

From the analysis of the four different projects, two major limitations of the digital opportunities model have been identified. First, during the planning and implementation of the projects, the meaning of equity was understood only as a matter of material access and digital skills. However, the outcome of the projects indicated that equity in these two aspects may be a necessary first step, but is not sufficient. To address the issue of digital divide in learning, there must also be equality in learning outcomes beyond just access and skills. According to different researchers in the field, equity of students' learning outcomes depends on factors like: (a) the attitude and motivation of students towards technology, (b) the nature of technology usage by students and (c) students' capability of meaning making (Jones & Issroff, 2007; Van Dijk, 2006; Wei, Teo, Chan, & Tan, 2011). A second limitation was the lack of detailed forethought by planners and policy makers in understanding how learning activities and environments are affected by the introduction of ICTs. According to Salomon (1993), *"Introduction of ICTs redefines the whole activities and interpersonal relationships inside and outside of the classroom"*. Integration of ICTs into the learning process has the potential of redefining the learning activities in formal as well as in informal learning spaces; therefore activities in both of these learning spaces can have a significant impact on learning outcomes. So, investigation of the integration of ICTs into the learning process should include both formal learning spaces like classrooms and informal learning spaces like outside of the school and home.

AGENDA FOR STUDY

The results and experiences of the digital opportunities projects raised several implications for future projects with similar aims. The evaluation of the digital opportunities projects has also confirmed that there is a need to rethink the educational aims underpinning the concept of ICT initiatives and the process by which such concepts are translated into practice in schools.

In response to this, the New Zealand Ministry of Education developed an ICT strategic framework for education in 2006. The goal of the ICT strategic framework was to develop a more learner-centered service culture where education agencies and organizations focus on the outcomes rather than the technology through improved connectivity (access to

ICT infrastructure for education), content (digital content from variety of sources), and confidence & capability (skills needed to turn information into knowledge). Currently there are eleven different digital opportunities projects on-going around New Zealand, aiming to contribute towards bridging the digital divides in learning. However, after analyzing all current projects it has been found that even current digital opportunities projects are unsuccessful in fully embracing the vision and goals of the ICT strategic framework for education and taking into account the lessons learned from the previous initiatives. Despite the lessons learned from past projects, all of the currently on-going projects are still focusing either on the access or the capability aspects, which is not much different than in the previous digital opportunities pilot projects.

Results and outcomes of the past and current initiatives show that not every aspect has been taken into account during the implementation of the initiatives. Each of the past initiatives either focused on the access or skills aspects. However, while ensuring equal access and skills is necessary first step, ensuring improved and equalised learning outcomes is also an important aspect towards bridging the digital divide in the learning process. From the analysis of the past and current digital opportunities projects, we have identified some of the potential factors which might affect the process of learning in the context of integrating ICTs, and may also impact the quality and equality of learning outcomes either positively or negatively. These factors are:

1. Learner Dependent Factors (attitude and motivation of students towards technology, nature of technology usage by student, students' capability of meaning making)
2. Learning activities in formal spaces
3. Learning activities in informal spaces

Studies on how learning outcomes could be affected in the context of ICT mediated learning and how this may impact the digital divide in the learning process are not well represented in the literature. So, those factors which have been identified as the potential factors and which might affect the quality and equality of learning outcomes need to be investigated in a relevant context.

PRELIMINARY ANALYSIS OF BYOD PROJECT

A New Zealand school has decided to fully integrate ICT into the learning process in the form of 1 to 1 learning devices for all students in a cohort. The school informed all parents and students, that they were expected to bring a 1 to 1 digital learning device (preferably an iPad2) into the classroom in year 9 (students aged 13-14) for the 2012 academic year. The most controversial and unique aspect, which makes this initiative different from most others, is that the parents have been told they must cover the full cost of the required digital learning devices for their children, whereas similar projects in the past (like the digital opportunities projects) have provided devices through the schools. The bring your own device (BYOD) project at this school provides us with an appropriate context to investigate the integration of ICTs into the learning process and to make an attempt to address some of the issues which previous digital opportunities projects have raised.

The school's decision resulted in a high profile news story in the New Zealand Herald, a national newspaper, triggered by a complaint from a parent about being asked to buy a digital device for their child. This triggered a huge public and media response, leading to news stories on TV and radio, and online debates on various news sites and forums. This led us to focus our initial research on the public debate, in an effort to identify important themes and concepts that could inform our research questions for the whole study. We therefore collected data from as many relevant public forums as we could identify, then qualitatively coded this data and analysed it using NVivo 9. Although many of the contributions to the debate were not considered because of the very general nature of the comments or, in many cases, because the comments were simply offensive, analysis of debate highlighted some of the possible challenges for the BYOD project as shown by the themes summarized in Fig. 1.

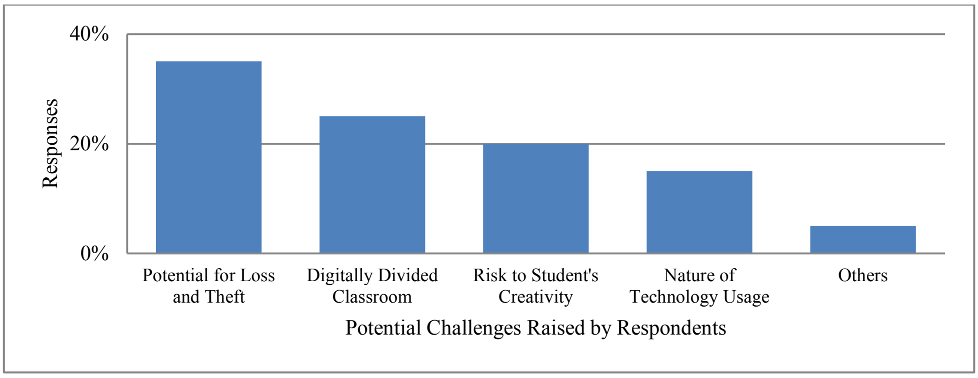

Figure 1: Analysis of the Public Debate over BYOD Project

Almost 40% of the responses were concerns regarding the potential for loss, theft and damage of the device, but this is not relevant for the study. In fact, 6 months into the trial, only 2 devices had been damaged and none had been lost or stolen. Another widely expressed view was related to inequality in terms of device ownership. Nearly 20% of the respondents expressed their concerns that the classroom may become digitally divided. As some students may enjoy the benefits of the device or regard it as a status symbol within the classroom, students who do not have the recommended device, or any device at all, could possibly feel disadvantaged, which could result in unequal learning outcomes. About 20% of the contributors expressed views about meaningful use of the technology by the students. Some contributors who introduced themselves as parents said that even if they could afford the device they were more concerned about the unsupervised access to resources which their children will be exposed to via the internet and think some of the resources might not be useful for them or may even be harmful.

From the analysis of the digital opportunities project and findings of the analysis of the public response data we have been able to form some general research questions for the study. The main research question for our study is: *How does one-to-one integration of ICTs into formal and informal learning spaces impact the digital divides?*

1. *Which factors could impact either positively or negatively on equality of learning outcomes?*
2. *How can the positive or negative impact on the learning outcomes be increased or reduced respectively?*

A SOCIO-CULTURAL ECOLOGICAL MODEL AS A MEANS OF ANALYSIS

There are many theories and frameworks which have been used as a means of analysis to study learning with mobile devices and technology mediated learning process, but the socio-cultural ecological approach to mobile learning has been adopted for this study. This framework has been developed in response to the perceived need for a coherent theoretical framework to addresses the limitations in the existing theories to investigate the learning process within the formal and informal learning spaces mediated by one-to-one ICTs. Three main components (Agency, Cultural Practices, and Structures) characterise the ecological approach to learning with mobile learning technologies (Cook, Pachler, & Bachmair, 2011). This framework sees learning through mobile devices in and around different learning spaces and is governed by a triangular relationship between socio-cultural structures, cultural practices, and the agency of learners, represented in the three domains in Fig. 2 (Pachler, Bachmair, Cook, & Kress, 2010).

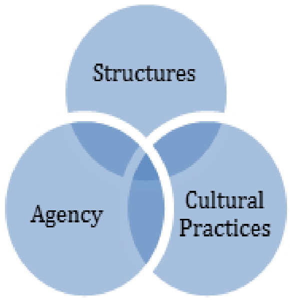

Figure 2: Socio-cultural ecological approach to mobile learning (Pachler et al., 2010)

- **Agency:** Agency in the framework refers to the capacity of the individual to act and interact within educational and sociocultural settings to make their own free choices. In our study, agency is appropriate to analyse how the learner adapts or appropriates technologies into their learning processes based on the capacity and expertise they have. It can be used to analyse the learner dependent factors like attitude and motivation of students towards technology, the nature of their technology usage, and their capability of meaning making.
- **Cultural Practices:** Refers to the media use inside and outside of educational institutions and media use in everyday life. In our study, cultural practice is appropriate to investigate learners' ICT usage within different learning spaces and analysing and linking their learning activities both from formal and informal learning spaces.
- **Structures:** Structure is something which governs learners in and around different learning spaces. This can be appropriate to analyse the curricular frame of the school and the social norms of the education system and wider society which govern the activities of the learner.

RESEARCH METHODS

This study has been divided into two different phases and each phase of the study is employing different research methods. A case study approach has been considered appropriate for in-depth investigation of the one-to-one integration of ICTs into the learning process to see how this might impact the quality and equality of the learning outcome in phase one. This research is planned to introduce some form of ICT intervention in the technology mediated learning process in the second phase, aiming to reduce negative impacts and improve the positive impacts of ICT integration in the learning outcomes. Therefore, the research method in second phase will change into a combination of case study and action research.

FINDINGS FROM THE BASELINE DATA ANALYSIS

The baseline stage of collecting data has already begun, through classroom observation, online surveys and individual interviews with students, teachers and parents. Some important findings have emerged from the analysis of the survey and classroom observation data, which provides us with insights into the different aspects of the study.

- Although the student survey response rate was only around 30%, data indicates almost every student has access to the computers and internet at home and school. This indicates there is not a significant gap in terms of material access.
- The student survey data shows significant variation in the level of digital skills. Only a small percentage of students have reported that they have an advanced level of ICT skills. However the majority of the students said they have a competent or intermediate level of skills. The survey revealed that there are still some students who have only basic or beginners' level of digital skills. This disparity in the digital skills among students could become a barrier for some to make meaningful and efficient use of the one-to-one ICTs in their learning process.
- The survey data also revealed a n umber of skills and capability issues with the teachers. Only around 65% of teachers reported that they have competent digital skills. The rest said they have either intermediate or basic digital skills. This variation in the digital skills of teachers may emerge as one of the challenges for teachers in successfully integrating ICTs into their instructional activities. In another question, only 15% of teachers reported that they don't have sufficient skills (capability). Though 15% is not a very big proportion, for the successful integration of ICTs for bridging the digital divide into learning, this is still likely to become a barrier.
- The survey shows that more than 50% of students usually spend most of their time on-line in social media activities, entertainment, and gaming, though there are also significant numbers of students who spend most of their time on-line in educational activities. Since the majority of students are spending most of their time in non-educational activities, this may affect the quality and equality of learning outcomes between those who use ICTs for mainly educational purposes and those who use it for non-educational purposes.
- Teachers reported mixed feelings about the improvement of students' performance by integration of one-to-one ICTs in learning. 62% of the teachers believed that this initiative will be helpful to improve the academic performance of students, but there were around 25% of teachers who have said that this will make no difference in students' performance.

Data from interviews and observations is still being collated and analyzed. We expect that this will provide further insights into the current state of the BYOD initiative.

CONCLUSION

When ICTs are integrated into the learning process in the form of one-to-one digital learning devices, various factors dependent on learners like motivation and attitude towards technologies, nature of technology usage, and learners' capability of meaning making, could affect learning activities in formal as well as informal learning spaces. These effects beyond just access and skills could impact either positively or negatively on learning outcomes.

The BYOD project and the theoretical framework adapted for the study allows us to generate a comprehensive research agenda to investigate integration of one-to-one ICTs into the learning process from different aspects, to find how it affects formal and informal learning activities and impacts the phenomenon of digital divides in learning. At this stage, we have only completed the base line data collection. End of the year data collection will be completed in December 2012. With this data we will be able to assess the evolution of the project and propose new interventions to support its aims. The results of this study may inform policymakers, school administrators, and teachers about how to conduct successful integration of ICTs into the learning process.

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Challenges facing eTextbook provision to South African schools

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ABSTRACT

One of the mandates of the Department of Basic Education (DBE) in South Africa is to distribute textbooks to both urban and remote rural schools. The challenge that the DBE faces in this regard is that the distribution machinery has not been that efficient, resulting in some schools opening without the necessary textbooks. Distribution problems to schools has also meant that some schools are using outdated books, especially now that the new CAPS curriculum has recently been introduced. This article reports on the alternative to paper book provision in South African schools, in the form of provision of eBooks to schools. This means making available digital books that can be downloaded to the various schools to avert problems associated with distribution delays and to ensure that books that are aligned to the current curriculum are available at any point in time.

Although eBooks in general have many advantages, South Africa cannot subscribe a uniform solution to all schools. It is the current information and telecommunications technology (ICT) infrastructure and financing of such a project that determines the mode of eBook provision at the end of the day. Not overlooking the fact that there is a serious digital divide in South Africa, which pits the well-endowed urban schools against the poor-resourced deep rural schools, a number of recommendations on how eBooks can be made available to schools are outlined in this research. The proprietary eBooks and eBook readers as provided by the established international companies are very expensive for the South African environment, and this would result in uneven access to such resources. Therefore South Africa has to come up with its own low-cost appropriate technologies to enable eBook provision to the schools. The option is to take advantage of the current ICT infrastructure that has been rolled out by the government in the form of projects such as computers for schools. The problem is that this sort of infrastructure hasn't been rolled out to all schools yet, with the deep rural schools unlikely to have any such computer networks. Where there are, these school networks can be configured for eTextbook accessibility via desktop computers, laptops, tablets and Smartphones for those that cannot afford the proprietary eBook readers. Mobile access is approaching 100% in South Africa, although there is no guarantee that the phones that are in the hands of the majority of the people support internet access and multimedia services. The DBE should set up its eTextbook store which comprises content by local publishers, is customised to the local environment, has the appropriate digital rights management (DRM) in place and can be easily accessed by these schools.

Author Keywords

eBooks, eTextbooks, education, ICT, eBook readers

INTRODUCTION

Against considerable data demonstrating that education and literacy are key drivers of economic growth and that there is correlation between low literacy and high poverty levels in the developing world (2005 World Bank Development Indicators database) and that access to books can boost reading ability, South Africa's Department of Basic Education (DBE) is looking at the prospect of introducing eBooks to boost reading. eBook refers to electronic files of words and images that are of book length, formatted for display on one or more devices known as eBook readers and sold or distributed as stand-alone products. eBook readers are defined as the devices used to read eBooks. These could be handheld or not, dedicated or not. The software that enables the display of eBooks on PCs or other devices would be referred to as eBook reader software, even though some software companies such as Microsoft refer to their applications as readers (NetRead, 2000). eBooks can also be defined as a text in digital form, a book converted into digital form, digital reading material, a book in computer file format, an electronic file of words and images to be displayed on computer over a network, or viewed on a desktop/notebook/dedicated portable device, or read on all types of computers, or formatted for display on eBook readers (Jenkins, 2008). There is a growing range of eBook readers, that is, devices created specifically for storing and reading eBooks, each of them exploring one aspect of the paper book , that is, portability.

In the process of boosting reading though, we must not overlook the fact that South Africa has two extremes- the well-ICT-endowed urban areas and the deep rural areas which have no ICT infrastructure at all. What then would be the best approach to provision of eBooks to all South African schools? This research is structured to introduce case studies of eBook provision in a number of countries including South Africa and draws lessons from their experiences. It looks at the current South African environment and recommends a South African solution to eTextbook provision.

LESSONS LEARNT FROM ETEXTBOOK INITIATIVES IN OTHER COUNTRIES

The following are examples drawn from some eTextbook initiatives in Ghana and the USA

WorldReader is an initiative that brings eBooks to people in developing countries. Ghana is one such recipient. Between 2010 and 2011 WorldReader conducted a pilot study whose purpose was to bring eReader technology to gauge how well students cope with it and use it to study. The pilot project was called Impact on Reading of eReaders (iREAD) (iRead, 2010) and it provided Kindles and eBooks to students in 9 different cities. Local content was created by digital conversion of 82 Ghananian books. The learners learnt to use the eReader very fast. They ran into problems like accidentally deleting books, or being distracted by non-reading functions such as music. The following lessons were concluded from the pilot:

- ❖ Out-of-classroom reading is critical to the success of learners.
- ❖ Children were allowed to take eReaders home. As a result of the devices breaking too often, protective cases had to be provided. Lights were also provided for reading at night
- ❖ It is necessary to transition from a single user eReader model to a library model. This model would significantly reduce the numbers of eReaders required at any school
- ❖ WorldReader negotiated the rights with Amazon to use the books across hundreds of eReaders since Amazon systems impose a maximum of 6 Kindles sharing the same book simultaneously.
- ❖ Each eBook ranges from a few hundred kilobytes to several megabytes depending on the length, number. of pictures, etc. When multiplied by the large number of eReaders accessing at the same time, this represents an enormous amount of data. Simultaneous access becomes difficult due to bandwidth constraints.
- ❖ Building an entire ecosystem around eReaders where consumers can buy eBooks using credit from scratch cards, similar to prepaid mobile phone, was devised.

California's Free Digital Textbook initiative (California Learning Resource Network, 2012), uses free digital textbooks in various subjects for use by the state's public schools and teachers sharing their online and self-created materials. The books are openly licenced under a Creative Commons (CC) licence. The initiative focuses on open educational resources (OER) movement. The licence gives the educators the power to remix, share and distribute materials as needed to be timely and maximally relevant to the curriculum. The lessons drawn from this initiative are as follows:

- ❖ The flexibility afforded by a CC licence allows for material to be adapted quickly. Many topics in the science and technology domain are changing so quickly that education can no longer afford to wait for proprietary material to go through their lengthy cycles of publication
- ❖ Most teachers do not have the access, training and support necessary to confidently participate in the OER movement
- ❖ The traditional textbook pricing model is not really scalable, especially not so for money-strapped schools. So it makes sense to use free alternatives instead.

The Siyavula initiative (Siyavula, 2012) project allows pupils from Grade 10 to 12 to download Maths and Science textbooks free and provides videos and presentations that they can source via the internet or on cell phones. The textbooks are written by volunteers and are provided free of charge to schools. It costs the government only R40 to print and distribute one of these textbooks, whereas previously the Department of Education had to pay R150 a book. Schools can download the books and print them at their cost. The content is licenced and used free of charge.

The books can be freely copied, printed and distributed as often. It can be downloaded onto mobile phone, iPad, PC, flash drive and can be burnt on CD, emailed around and uploaded to a website. The only restriction is to keep the book, its cover and short codes unchanged. All exercises inside the book link to a service where the learner can get more practice, see the full solutions, or test their skills development on mobile and PC. The eBooks are accessible on www.everythingscience.co.za and www.everythingmaths.co.za The lessons learnt so far are that:

- ❖ Locally-produced content is appropriate and low-cost
- ❖ This local content can be licenced on an open access licence to the benefit of local schools and can be freely copied, printed and distributed

The Yoza project is available on MXit in South Africa and Kenya (Yoza, 2012). Originally known as m4Lit (mobile phones for literacy), it explores the viability of using mobile phones to support reading and writing. It targets the youths with engaging stories that include stories from genres such as soccer issues and teen romance. The lesson learnt is that:

- ❖ South Africa can take advantage of cell phone technologies in the provision of eTextbooks

CHALLENGES TO ETEXTBOOK PROVISION IN SOUTH AFRICA

There are a number of challenges to eTextbook provision in South Africa.

There is no common eBook format among eBook providers. The eBook market is characterised by proprietary ownership. eBooks can only be accessed using particular eReaders. The Barnes and Noble bookstore can only be accessed using the Nook, Amazon bookstore can be accessed using the Amazon Kindle, etc. If South Africa is thinking of purchasing from these established bookstores, does it mean that these bookstores stock textbooks that are specific to the South African curriculum? Traditionally, inventories of goods offered by any single vendor are limited. On the other hand, proprietary formats are equipped with digital rights management (DRM). This technology controls access and is used to protect copyright material and limit usage of digital material and devices to those that have rights of access (Kumar, 2009). The eBooks cannot even be shared among devices in some cases. One owning different types of readers have to purchase the same book more than once. At the same time, the cost of hosting eBook content, maintaining platform features and providing technical support increases the cost of eBooks. Pricing models are varied from publisher to publisher and vendor to vendor. If a South African solution is required for content production, that will go round the proprietary nature of eBooks and eBook readers, local content producers will have to be trained. Currently there is a shortage of skills in that area.

eBook purchasing options vary and several factors must be considered before ordering. Will it be purchased as a subscription, one-time with perpetual access, or as a selection through patron-driven acquisitions. eBooks ordered as a subscription are purchased annually. If the subscription is cancelled, all access is lost. eBooks purchased with perpetual access are owned by the library. The cost of the perpetual access eBook is usually higher than the subscription option and does not include any revisions or updates. Another option for purchase is patron-driven acquisition. In this model, the library has an agreement with the vendor, to load records for a collection of titles into their online public access catalogue. If a given title is accessed a certain number of times, as agreed in the contract, the library purchases the title. Many publishers such as Elsevier, Wiley and Springer require that every eBook title purchased must be added to the university licence through an addendum and signed by both parties (Jackson, 2011). eBook purchase is not a simple purchase as in case of print books, but continues to send annual access fees

If it is just a case of provision of eBooks that are of a standard nature, connectivity is not an issue. Download can be via the internet for those schools that have access to the internet, and offline for those that do not have. Schools should already have their own computer networks, if the computerisation of schools is a successful project, that is. Currently, some schools do not have computers and licencing of software is beyond them. The challenge though is not only about the cost of deployment of infrastructure to support eBooks but also the cost of maintenance of the infrastructure. Schools do not have the required technical support personnel. Energy is required to run an eBook. Unfortunately not all schools have access to a reliable energy supply, in particular those in deep rural areas. Not everyone has access to eBook technology too. There still exists a digital divide in South Africa. Therefore we cannot subscribe an umbrella decision on provision of eBooks to all schools.

The schools have to ensure that their stock of eBook readers are kept intact. The problem is that these eBook readers are in the hands of young, immature children, and hence there is no guarantee that they will be secure. Even security of eBook readers which can be kept within the school premises, has to be ensured. Once any readers get the lost, then a vicious cycle of thefts will occur, and at the end of the day there will be problems of access to eBooks. Schools with such equipment would have to invest in expensive alarm systems and surveillance cameras. But such equipment is beyond the reach of most schools which are already underfunded. Leaving eBook readers in the hands of learners puts them at risk of being the targets of criminals, just as cell phone technologies have been. That would mean that the DBE has to have a constant supply of eBook readers, and most probably as frequently as paper costs. Introduction of eBook readers will lead to an increase in potential sources of e-waste. E-waste is discarded electrical/electronic devices that pose a health risk to communities due to leaching of material such as heavy metals from landfills

Authors and publishers are wary of digitising their works, as these are more likely to affect their profits when copyrights are violated. In storage, transmission and download pose security threats. How do we ensure that the eBook that is downloaded to a reader is only made available only to the person who is authorised to have it and cannot be copied? Currently regulation by publishers restricts the number of pages that can be downloaded via software search.

Staff are not properly trained to deal with and make use of new technologies that they are provided with; providing adequate equipment and keeping them running smoothly and up-to-date is difficult, in terms of finding the money to provide for them and also the expertise; ongoing funding is hard to maintain, with education departments usually not having enough money to pay staff, let alone fund computer equipment; and lastly integration of computers and related technology into the school curriculum. An educator is not necessarily trained in ICT., and education institutions are not offering that training. Therefore schools need to employ ICT professionals. Unfortunately ICT professionals expect market salaries which are well above educators'.

RECOMMENDADTIONS ON ENABLING ETEXTBOOK PROVISION

The DBE should come up with an eBooks store of recommended textbooks. It should be encouraged to give incentives to local authors and publishers to develop local content for these eBooks. The eBook store can play the role of a library. The only problem is that a library carries a whole range of books some of which are from external sources. In this case a single standard in textbook format to enable access by all is required. This would be formats that are not protected such as .pdf, .mobi, plain text, etc. The eBook store should allow content to be remixed, shared and distributed (Dlodlo, 2011). To ensure that only authorised schools have access to the resources, each school should have an access licence. Just like in the California Free Digital Textbooks initiative, the OER movement should be encouraged, so that the skilled teachers can contribute content under an open access licence.

The current school networks should be configured to enable download of eBooks from the DBE eTextbook bookstore. The store should allow simultaneous access and the availability of the required titles. To tackle exclusion, setting up a network of community based ICT centres and multiple eBook access points to complement any access would suffice. This would mean that those that would not have access to eTextbooks in their schools can take advantage of such. This can be through public access facilities such as Thusong centres, through public information terminals at post offices and libraries , internet cafes and kiosks.

Instead of total changeover from paper books to eBooks, a hybrid approach can be adopted. Schools that have the resources such as electricity and finances for technology purchase and skilled teachers can introduce eBooks. Any savings from the introduction of eBooks into such institution can then be ploughed into those schools that do not have the infrastructure.

In cases where finances area available the DBE should fund a cheap eBook reader that is rabid and supports a mechanism that allows only the authorised learner to use it. The DBE can design their own format of an eBook reader and put DRM on it that can only read the school books that learners have rights of access to. It won't be worth selling to anyone else, hence security and copyright is ensured. To pass a DRM is easy, hence biometric identification of the learner can be the next source of security of the content. Learners can also access formats that are not protected such as .mobi, .fb2, plain text and .pdf

Once content of the eBook has been created, the master file of the eBook can be downloaded, either offline or online to the loading station of the school to upload to eReaders. The offline / online download will be determined by whether the school has internet access or not It is important to transition from a single reader to library reader model, if the case is for the provision of books which are in short supply. This means that the funds towards infrastructure are reduced. Digital TV has the potential to reach 100% of the population although now it stands at 60%. The digital TV pushes content to the viewers. This material can be pushed to the memory of the decoder and then downloaded to the school servers

Without the necessary infrastructure, schools in less developed areas will continue to lag behind. Therefore the need to accelerate government programme for the installation of ICTs in schools. An eBook replacement and upgrading strategy has to be put in place to avoid the glitches in eBook provision.

CONCLUSIONS

There are a number of challenges facing textbook provision to South African schools, including an inefficient textbook distribution network. This research looks at an alternative book supply option in the form of eTextbook provision. The challenge though would be that of inadequate ICT infrastructure that would hinder equal access by all. The paper looks at the challenges and makes recommendations on how this situation can be resolved. The research proposes that the DBE come up with its own eTextbook store that is based on an open-access licence. Learners can access this store through their school networks and on mobile technologies. Those without networks can access through public facilities such as libraries, Thusong centres and kiosks. The initiative should draw lessons from current South African eBooks initiatives like Siyavula before any decisions on the way forward are made.

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Ambient Learning Displays: lecture series and results from a participatory design study

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ABSTRACT

Emerging from pervasive and mobile technologies, ambient displays present information and media in the periphery of the user. Thereby the displays situated and interacting in the close proximity are an addition to existing personal interfaces in the foreground, while the user attention can always move from one to the other and back. Especially the ability to deliver contextualised and personalised information in authentic situations fosters ambient displays as an instrument for learning. However the actual design of ambient displays for learning proves to be difficult, as the technical implementations as well as the underlying instructional principles are still immature. The paper presents the main constituents of a lecture series on the use of ambient displays for learning and a first participatory design study conducted during two consecutive lecture sessions. The results show a variety of usable ambient display types, possible learning scenarios, and specific design proposals towards ambient learning displays.

Author Keywords

Ambient Learning Displays; Participatory Design; Conceptual Framework; Ubiquitous Learning Support; Situational Awareness; Feedback; Lecture

INTRODUCTION

Definition

Following linguistic definitions the compound term ambient displays characterises appliances present in the close proximity of mainly visually solicited receivers. Thereby the adjective ambient is defined as "relating to the immediate surroundings of something" or "relating to or denoting advertising that makes use of sites or objects other than the established media" (Oxford Dictionaries, 2010), while the noun display is among others defined as "a collection of objects arranged for public viewing", but also as "an electronic device for the visual presentation of data or images" (Oxford Dictionaries, 2010). Wisneski et al. (1998) finally introduced ambient displays as "new approach to interfacing people with online digital information". Inspired by Weiser's vision of ubiquitous computing (Weiser, 1993) the "information is moved off the screen into the physical environment, manifesting itself as subtle changes in form, movement, sound, colour, smell, temperature, or light" (Wisneski et al., 1998). Instead of demanding attention the approach exploits the human peripheral perception capabilities.

Theoretical Approaches

Following Wisneski's view (Wisneski et al., 1998) on ambient displays awareness can be deduced as a main instructional characteristic of ambient displays. To grasp the application possibilities of ambient displays in learning contexts this concept needs to be further exploited and theoretical approaches like situational awareness (Endsley, 2000) need to be considered for an instructional perspective. Endsley defines situational awareness as "the perception of elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future". Following this definition the author presents three levels of situational awareness that can be used for classification, namely perception, comprehension, and projection. Especially on the higher levels of situational awareness the type and characteristic of feedback given by the ambient displays plays an essential role for their effectiveness, impact, and behavioural change capabilities and thus is another important instructional characteristic that can be deduced. In that sense also the concept of providing (instructional) feedback (Mory, 2004) needs to be incorporated.

Conceptual Design

In a first attempt to facilitate the design of ambient displays for learning the authors examined relevant research findings, models, design dimensions, and taxonomies based on the assumption that the information presented in context needs to be acquired, channelled, delivered, and framed in the learning process. The result is a conceptual framework that provisionally defines ambient learning displays (Börner, Kalz, & Specht, 2011) and consists of parts dedicated to acquisition, channelling, delivery, and framing.

An example of an ambient display that also fits well into the conceptual design framework, is the "Elements" prototype by (Gyllensward, Gustafsson, & Bang, 2006). The authors designed the alternative radiator information display consisting of 35 light bulbs to visualise the invisible energy consumption of radiators at home. The display utilises solely internal and external temperature sensors as source of information.

METHOD

The presented participatory design study has been conducted during two consecutive lecture sessions on the use of ambient displays for learning with the goal to inform and ease the design process. The participants were asked to fill out a short participatory survey during the sessions. The survey consisted of three parts dedicated to ambient learning display (a) types, (b) scenarios, and (c) designs as well as some demographic information (i.e. age, background, gender).

The participants were asked to fill in each part separately within one minute after an introduction on each subject matter and an explanation on what is expected from them. The parts were introduced following the presented foundation underpinning the research on ambient displays for learning, i.e. definition of the ambient display concept, theoretical approaches, conceptual design framework, as well as examples.

RESULTS

In total 28 participants (22 male, 6 female) in the age between 21 and 44 filled out the survey. Thereby most participants have had a computer science background, with only some exceptions coming from health care, psychology, or technology-enhanced learning. The reported results are structured into the three parts (a) types, (b) scenarios, and (c) designs. Table 1 lists the main results per survey part.

Ambient Display Types

When asked to come up with usable ambient display types, some participants described in some form or another existing displays already used to convey information, e.g.

"flat screens in the lobby", "whiteboard in room", "digital screens, placed on walls or tables", "display embedded in the mensa", "commercial board", "Billboard like large display", "wall clock".

Others described enhanced versions of technical appliances, so far not necessarily used to convey additional information beyond their intended purpose, e.g.

"Speed Control", "Smart Pen", "automatic dough analyser within bowl", "electric toothbrush, but smarter", "mp3 player", "weights display", "power outlet", "mobile device", "bus stop", "desk".

Although all the mentioned appliances pragmatically fulfil their specific functionality, they apparently lack a certain degree of feedback on the respective user actions performed with the appliances. The remaining participants then described new display types utilising mainly visual appliances, such as glass, windows, or mirrors, e.g.

"view from my living-room window", " window, mirror in the bathroom", "Display on glass", "windows in cars".

Learning Scenarios

Besides listing ambient display types, the participants were also asked to describe potential learning scenarios where these displays could be used. Following the theoretical approaches introduced and explained, the results can be grouped according to the main objective of increasing awareness, providing feedback, or learning.

Awareness

The scenario described most by the participants is the provision of "information within context related to the current situation/needs". Other scenarios described exemplify this concept, e.g.

"every time I enter our work building […] show some nice ti[t]bits of information [e.g.] next agenda item", "Display giving information about buildings around you", "remind me of appointments and the possibility of being late/on time", "display/project material (e.g. slides, documents) at anytime and everywhere", "showing weather in the street", "nutrition of food", "random historical info/trivia about [the city]".

Obviously the ambient displays in these scenarios are mainly used to support users by increasing awareness of contextual information. The only exceptions described by participants are a "display [that] shows different landscapes" and a display that visualises "how many cyclist[s] passed the bridge". These displays also increase the user's awareness, but do not provide comparable support.

Feedback

Beyond increasing awareness the participants also assigned scenarios where ambient displays provide feedback, e.g.

"the display warns you by blinking", "feedback about: maturity, resistance, fluidity, time to go", "present countdown", "sport training […] calculating all necessary data: tempo, blood pressure, speed, time etc.", "the energy consumption of an outlet", "running speed", "driving information".

Mostly this provision facilitates immediate reflection on the performed action. Additionally the provided feedback might also include suggestions on how to adapt or improve respective behaviour, e.g.

"identify […] hand writing and offer some suggestions to improve his/her hand writing", "[how] to brush teeth", "what to do next", "current weight […] recommendations what to eat, should you make more exercises".

Notably all these scenarios describe a reoccurring cycle know as the feedback loop, whereas the performed action immediately feeds back to the assessment and reflection on the action and so forth.

Learning

Finally the other scenarios described by the participants depict the acquisition of factual, conceptual, or procedural knowledge and thus learning in various forms partly building up on awareness and feedback, e.g.

"learning of languages […] helping to improve pronunciation or build-up vocabulary", "preparing for TOEFL exam […] help me memorize the vocabulary", "display facts – ask for facts".

Two interesting scenarios mentioned here are the comparison of "the sun's relative position" and learning "how to prevent 'bad air'" in a room. Both have the potential to encourage an ambient display design with a real added value compared to other learning designs or technologies.

Survey part		**Results**
Ambient Learning Display	Type	(Embedded) display screens, billboards
		Technical appliances of daily use (e.g. toothbrush, clock)
		Glass, windows, or mirror displays
	Scenario	Awareness of contextual information (e.g. agenda, nutrition, weather)
		Feedback on user action (e.g. sports, cooking)
		Learning languages or psychomotor skills
	Design	Addressing various senses (focus on visuals and lighting)
		Non-disruptive (e.g. gesture-based interaction if needed)

Table 1. Survey parts and respective results

Ambient Learning Display Designs

Incorporating the previously described ambient display types and learning scenarios, the participants showed differences in terms of innovation, creativity, and accuracy when describing the actual design of their ambient learning display. Ranging from pragmatic descriptions, e.g. "[…] light up picture of device", up to more detailed implementations, e.g.

"display map of teeth on mirror, showing the […] teeth that need more attention […] in combination with motion sensors shows child on mirror where he/she is brushing [or needs to brush]", "display shows different landscapes, places, cities and plays also the respective sounds (+smell); content can be selected and played randomly or customised on daytime or mood".

Others were clearly inspired by recent technical developments or announcements, although extending the functionality or using them in a learning context e.g.

"Could be implemented as a screen or goggles providing information on objects that a person sees. The objects could be named, translated into the language of a user. Additionally a sound system could be used to teach the user […] proper pronunciation".

Interestingly most of the designs described by the participants address various senses, while the main focus remained on visual aspects like lighting, e.g.

"Tells you by light, sound and maybe smell that you should open the window [e.g.] very soft music, light turns red", "They don't necessarily want to take a look at the screen – just feel it […] Beside traditional displaying the weather, it can use strong light for sunny weather, blow air for windy, sound for oncoming storm, etc.".

One participant goes even further, including not only senses but also sensor functionality, following the idea of utilising existing embedded displays, and even drafting possible interaction patterns, i.e.

"can push the words I currently recite on different ambient displays around my room […] When I reach it, it will show the meaning of the word. When I do some gesture, it means I already recited this word, so the display will show me a new word".

DISCUSSION AND CONCLUSIONS

The results presented show a variety of usable ambient display types, possible learning scenarios, and specific design proposals towards ambient learning displays. Regarding ambient display types and their design the results complement a recent literature review on the design and evaluation of ambient displays (Börner, Kalz, & Specht, Submitted). Beside depicting characteristics and classifying prototypical designs, the review also sheds light on the actual use of the covered ambient displays, their application context and addressed domains as well as the type of studies conducted, including the used methodologies and evaluation approaches to measure their effectiveness and impact. The participants of the participatory design study described different ambient display types, whereas the majority either utilised embedded display screens or billboards, converted existing technical appliances of daily use, or harnessed mainly visual appliances like glass, windows, or mirrors.

Furthermore the presented results depicting learning scenarios and ambient learning display designs complement another recently submitted literature review, that analyses work in the research field of ambient display with a focus on the use of such displays for situational awareness, feedback and learning (Börner, Kalz, & Specht, In Press). The review results expose that the explicit use of ambient displays for learning is not a prominent research topic, although implicitly ambient displays are already used to support learning activities fostering situational awareness by exploiting feedback. Congruently the participants had difficulties describing concrete learning scenarios and respective ambient learning display design. Mainly, the scenarios described by the participants had the objective to increase awareness of contextual information, provide feedback on user action, or support the learning of languages or psychomotor skills.

Overall the lecture series and the associated participatory design study help to ease the design process of ambient learning displays and inform the further research on this technological concept with great potential for learning. Thereby the focus is on the development of new display types addressing the whole range of senses as well as the utilisation of existing already embedded displays. Regarding learning scenarios theoretical concepts like (situational) awareness and feedback need to be incorporated to shape learning experiences so far not touched upon by ambient displays. The actual design of ambient learning displays remains challenging but not impossible.

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Context-aware Multimodal Interfaces Enhancing Ubiquitous Learning

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ABSTRACT

This paper proposes multimodal interfaces for a mobile learning system called SCROLL (System for Capturing and Reminding of Learning Log). The system is designed to help learners to record what they have learned (called as learning log) and recall their learning logs by providing them with quizzes. With the help of multimodal interfaces, learners can interact with the system by speech and body movements. It not only increases the entertainment of learning but also facilitates learners to use the system in the environment, in which it is not comfortable for learners to watch the display and input with keyboard. Another feature of the interface is that it adapts to the learners' context. It means that it can suggest learners to choose appropriate way to interact with the device in different environment.

Author Keywords

Multimodal interface, context-awareness, mobile learning, ubiquitous learning log

INTRODUCTION

Mobile learning is known as learning anytime and anywhere. And with the evolution of the mobile technology, mobile devices company the learners 24 hours. But it is still not possible for learners to study anytime and anywhere, because for most mobile learning systems users have to input using keyboard and receive the output by watching the display. But from morning till night, there are lots of situations in which learners' hands and eyes are not available, for example when we are walking, standing with heavy baggage, or wearing gloves. In such situations, they cannot input with keyboard using their hands or watching on the screen, but they can speak with their voice, move their body and hear with their ears. In these situations, a hands and eyes free interface are desired. Therefore, this paper proposes a multimodal interface which can increase the availability of the mobile learning systems.

The interface is built on a learning log system called SCROLL (System for Capturing and Reminding of Learning Log). The main functions of SCROLL consist of helping learners to record and share their learning experiences and recall what they have learned in quizzes. Usually learners can interact with the system by touching and viewing the display of the devices. However, even though mobile learning is thought to help learners with anytime and anywhere learning (Motiwalla, 2007), the normal interface is not available for them to use in some situations, such as when a learner is walking or the learner is wearing gloves. Therefore, to enhance the usability of mobile learning in such situations, a multimodal interface consisting of speech and body movements is proposed in this paper. What' more, the system can also be aware of the learner's environments such as whether it is too noisy for the devices to hear the learners' voice or whether the learner is moving at a high speed (like running) so that it is impossible for him to use the device and so on. Based on these judgments, the system can also suggest which interaction modality the learner should use.

The rest of the paper is constructed as follows. Next section introduces the related work. Then, both the "learning log" term and SCROLL are introduced in detail. In the fourth section, we describe the design of the multimodal interface. At last, conclusions and the future work are presented.

RELATED WORK

Before our study, many researchers have tried to enhance mobile learning using multimodal interface in the literature in technology enhanced learning field. For example, Wolff & Eichner integrated speech processing technology with a web-based e-learning environment in 2004 (Werner, Wolff, Eichner, & Hoffmann, 2004). Bischoff developed a text-to-speech interface on a context-aware mobile learning environment in 2007 (Bischoff, 2007). Motiwalla also did a case study on enhancing mobile learning using speech recognition technologies in 2007 (Motiwalla & Qin, 2007). In 2009, Kondratova discussed the multimodal interface in mobile learning and proved that it was technically possible to implement speech-based and multimodal interaction with a mobile device and to achieve significant level of user acceptance and satisfaction with technology (Kondratova & others, 2009). However, he also pointed out that there were some important contextual constrains that limit applications with speech-only interfaces in mobile learning, including social and environmental factors, as well as technology limitations (Kondratova & others, 2009). Thereby, in this study we manage to propose several possible kinds of multimodal interface for learners to break through those contextual constraints, such as body movement, which is also an effective interaction way studied by researchers (Jaimes & Sebe, 2007). The next section we firstly introduce the mobile learning system called SCROLL, on which our proposed interfaces are based.

WHAT IS SCROLL?

SCROLL stands for System for Capturing and Reminding of Learning Log. The term of learning log is defined as a recorded form of knowledge or learning experience acquired in our daily lives and it serves as memory storage for notable or important knowledge to review, to remind and to reflect (Li, Ogata, Hou, Uosaki, & Yano, 2012). For example, the notes taken in the foreign language learning can be called a learning log (shown in Figure 1(1)). But besides the text information, a learning log also contains photo, audio, video and some meta-data such as the location, time and so on.

An important goal of SCROLL system is to help learners recall what they have learned after they archived their learning logs. When a learner captures his learning log, besides the location based property mentioned above, a number of things are designed for learners to encode as retrieval cues. For instance, according to the picture superiority effect, the learning logs with pictures are much more likely to be remembered rather than those without pictures (Nelson, Reed, & Walling, 1976). In addition, according to the basic research on human learning and memory, practicing retrieval of information (by testing the information) has powerful effects on learning and long-term retention. And compared with repeated reading, repeated testing enhances learning more (Karpicke, Butler, Roediger, & others, 2009). For these two reasons, the quiz function taking advantages of the pictures, locations and so on is proposed. Three types of quizzes can be generated automatically by the system, which are image multiple-choice quiz (shown in Figure 1(2)), text multiple-choice quiz (shown in Figure 1(3)) and yes/no quiz (shown in Figure 1(4)). Because such three quizzes stands for the basic interaction way in mobile learning systems, how to support learners to do these quizzes in different situations are mainly discussed in this paper.

Figure 1 **(1) A learning log** **(2) Image-based Quiz** **(3) Text-based quiz** **(4) yes-no quiz**

DESIGN OF CONTEXT-AWARE MULTIMODAL INTERFACE

As far as we concerned, among all the human organs People's hands, mouth and head are possible for learners to input and eyes and ears can be used to catch the output. Table I and II show available human organs for input and output, the corresponding situations and the appropriate interfaces. The following sections describe two multimodal interfaces and a context-aware feature.

Available human organs for input	Situations	Interfaces
Hands	Normal way	Keyboard based
Mouth	Walking, wearing gloves, etc.	Speaking
Head	Studying in the library, traveling on the train	Body movement

Table 1. human-organs for input, used situations and interfaces

Available human organs for output	Situations	Interfaces
Eyes	Normal way	Display based way
Ears	Walking, driving.	Voice

Table 2. human-organs for output, used situations and interfaces

Speaking to the device

Voice modality is the first considered way when we cannot use our eyes and hands. And it has already been studied widely and proved to be possible. Among the three kinds of SCROLL, the text-based multiple choice quizzes can be assisted with this interface. For example, when learners speak the nature language, such as “Please give me some quizzes of Japanese” or “I need some quizzes of Japanese”, the system can interpret them into “get quizzes of Japanese”. Then, the system reads out the quizzes, learners can also provide their answers in voice. After recognizing the answers, the system will check the answers and provide more explanations in voices. Parsing Expression Grammar (PEG) technology can be used to analyze the construction of the speech to get both learners’ commands and their objects. Similarly, the system can also provide more different commands to support other system functions besides quizzes.

Moving your head

Besides speech, body movement way is also a possible way. This is because the front camera of smartphones can be used to track learners’ body movement. We propose to catch learners’ head movement. For instance, if the learner nods his head, it means “yes” while if the learner shakes his head, it means “no”. This kind of interface can be used in the social context that is not available to speak loudly, such as in the train or subway. This method can be used in the “yes-no” quizzes.

Shaking devices

Because the recent smartphones are equipped with a range of sensors, such as accelerometer, ambient light sensor, GPS, microphone, and so on, it is also possible to use these sensors to interact with device. For example, we propose to use accelerometer sensor on the device to catch the device movement in front and back direction or left and right direction. The front and back direction can be interpreted into “yes” while the left and right direction stands for “no”. This method can also be utilized in “yes-no” quizzes.

Situated multimodal interface

Because the interfaces of the system include three kinds: text-based, speech and body movements, it is necessary to recommend the learner to choose the appropriate method in different situation. Consequently, we can recommend learners the appropriate interface for learners by detecting the learners’ current environment via these sensors. Two aspects of the environment detected by the system are listed in the follows:

1. Whether the surround environment is noisy and whether learner is wearing earphone: This is used to judge whether the environment is suitable for the system to read out for learners and whether it is suitable for learners to respond the system using voice. The speaker of the device is used to detect the sound of the environment to judge whether it is noisy. The system can also check whether the earphone is working.
2. Whether learner is moving in a high speed. This is used to judge whether it is appropriate to provide a learner speech based interface, because it is impossible for learner to see the text information if the learner is walking or jogging. We distinguish learners’ movement way based on the Table III by using the speed data obtained from GPS.

Speed	*Movement Way*
0~5km/h	Walking (Knoblauch, Pietrucha, & Nitzburg, 1996)
5~10km/h	Running, Jogging, Riding on bicycle
10~50km/h	Bus/Car
>50km/h	Train/Subway (Toshiaki, Ryota, Hirokazu, & Tadashi, 2005)

Table 3 speed and movement way

CONCLUSIONS

This paper proposes a multimodal interface for mobile learning system. The interface is supposed to provide three benefits learners. Firstly, it will unbind the learners’ hands and provide a more comfortable way especially in quite a lot of situations, such as when the learners are walking. Secondly, it will provide a diversified way for learners to interact with the system and increase learners’ interests. Thirdly, the system can be aware learners’ environment and recommend appropriate interface option for learners based on the judgment of the environment. The multimodal interface contains the speech, shaking the device and tracking head movements. As for the future work, we will implement and evaluate the interfaces.

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Iterative design and delivery of high impact, multiple platform, scenario-based interactive mobile learning activities in the health sciences

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ABSTRACT

Mobile learning is an iterative process which follows the action-reflection model of action learning. In mobile learning, the drivers of this model are both new technologies and evidence of the efficacy of specific activities. This paper reports the second phase of The Virtual Human Body (VHB) project, a long running mlearning undertaking at The University of Queensland in the use of scenario-based activities in the teaching of biomedical sciences.

Early results from this phase of the project reaffirm that active mlearning activities need to be scalable in order to be universally accessible, and that a web-based design system allows the leverage of diverse, student-owned technology for academic benefit, permitting simple and easy adaption to new technologies, while literally providing a template for curriculum innovation, in terms of both flexibility of delivery, and dissemination to other curricula.

Author Keywords

mobile learning; interactive mobile learning; active mlearning opportunities; scenario-based mobile learning; biomedical sciences; emerging mobile technologies; SBLi; smartphone interface.

INTRODUCTION

Learning, as we have previously established (Ernst & Harrison, 2012), is an active process (Michael & Modell, 2003) and scenario-based learning is recognised as ‘active learning’. Moreover, the efficacy of scenario-based learning in health science education is well documented (Hoffman et al., 2006, Thomas et al., 2009). 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).

Consequently, the authors set out to design, develop and trial 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 that offers active mlearning opportunities (Ernst & Harrison, 2012). We found that both SBLi^{TM} versions offer high impact active learning opportunities, and that the active mlearning version (the SBLi^{TM} smart phone interface) was as effective as the desktop version (Ernst & Harrison, 2012). However, we also found (Ernst & Harrison, 2012) that the SBLi^{TM} structure with its “Location”, “Items”, “Actions” and “Collection” windows, and similarly structured scenario-based learning tools, do not lend themselves for conversion to a mobile learning environment. Feedback was that ease of usage and navigability of mobile learning applications are vital. Thus we concluded that active mlearning opportunities in future are best offered by uncomplicated web-based mobile learning applications with a HTML and Javascript touch screen interface (Ernst & Harrison, 2012).

Based on this conclusion, we migrated away from the SBLi mobile prototype template and developed a new HTML-based touch screen interface for mobile learning in physiology, anatomy and pharmacology, the Virtual Human Body (VHB). This new active mlearning application was introduced in two stages: a pilot was introduced and evaluated in Semester 2 2011 in BIOM1000 Physiology of the Human Body. User feedback and reflections were incorporated into an expanded version that is currently being introduced in Semester 1 2012 in BIOM2015 Physiology and Pharmacology of Human Disease.

Recognising the iterative nature of both curriculum development and delivery, and of technologies and their application to learning, (Chance, 2010; Muukkone & Lakkala, 2009; Kranch, 2008; Taylor & Evans 2005), the aims of this project were to:

- Recognise the near ubiquity of internet-enabled handheld devices using multiple operating platforms and systems, (Johnson, et al., 2012) and to create active, high-impact, decision-based learning opportunities;
- Create an uncomplicated, easy to navigate web-based HTML interface that ensures normalised access across all devices by working within the mobile browser environment, allowing the leverage of diverse but student-owned technology for academic benefit;
- Facilitate deep learning through consolidated understanding and application of learning in physiology, anatomy and pharmacology.

METHOD

The new VHB pilot was introduced in semester two 2011 to a student cohort of 135 first year health science students enrolled in BIOM1000 Physiology of the Human Body, at The University of Queensland, as a review tool to assist preparation for the end of semester examination. It contained four scenarios supported by multimedia resources and formative assessment tasks.

The four scenarios explored cardiovascular physiology and anatomy in the context of blood pressure regulation and the related pharmacology of antihypertensive drugs along with respiratory physiology, anatomy and pharmacology in the context of asthma. Each scenario commenced by presenting students with an action that elicited a response in the VHB. Alternatively, a sudden symptom (for example a headache or breathing problems) initiated a new scenario. Subsequently, students were presented with a number of hypotheses, as potential explanations for the initial response or symptom, and asked to use physiological tools to test this. This pattern of hypothesise, test and explain was repeated, until the student reached the correct conclusion. The distractor pathways of all hypotheses constitute authentic learning pathways in their own right, and included elevated intracranial pressure, head trauma, myocardial infarction and pulmonary embolus.

At various stages throughout the scenarios, students were presented with explanatory multimedia resources to complement the scenario , and were required to answer a series of formative multiple-choice questions (MCQs), in order to progress further. Similarly, students were offered a set of MCQs, to consolidate their learning at the conclusion of each scenario. As with the distractor hypotheses, all MCQ distracters were backed up by detailed feedback, thus ensuring each MCQ constitutes an authentic learning activity.

The expanded VHB version was redesigned using the open source content management platform DotNetNuke. It detects the type of device and operating system that is accessing the VHB and automatically determines appropriate content modules, including multimedia elements (e.g., video and images), for each particular device type. This required the VHB to have two different formats of video for the same video content—one optimised for mobile devices, the other for desktop computers. The current VHB operates from the mlearn.science.uq.edu.au URL. It was introduced in semester one 2012 to second year health science students enrolled in BIOM2015 Physiology and Pharmacology of Human Disease (n=58) as a review tool for students to prepare for the end of semester examination. However, a word of mouth campaign by the BIOM2015 students resulted in further students enrolled in other health science courses (mainly DENT2052 Advanced Biomedical Sciences for Dentistry (n=72) and PHYL2062/63 Physiology I [for Physiotherapy and Speech Pathology] (n=224)) utilising the VHB as a review tool in preparation for their own, different end of semester examinations.

The additional scenarios of the extended VHB pertain to blood glucose regulation and the pathophysiology of diabetes mellitus, and the physiology of acid-base balance in the context of diabetic ketoacidosis. Distrator hypothesis pathways included anaemia, hypothyroidism, Cushing's disease, alcohol intoxication, gastroenteritis, respiratory acidosis, lactic acidosis and renal tubular acidosis. Overall, the expanded version contained 34 multimedia resources that complement the physiology, anatomy and pharmacology taught in both courses. Some multimedia resources also introduced the learner to physiological and pathological tests including measuring blood pressure by auscultation, glucometry, oral glucose tolerance testing, electrocardiography, spirometry, CT scans, and various blood tests.

Quantitative evaluation is be based on internet traffic statistics, student feedback on perceived efficacy of active mlearning (online student questionnaire with five point Likert-type scales on SurveyMonkey embedded in the VHB), and on comparison of year-to-year learning outcomes as measured by student performance in summative assessment and grade distribution. In addition, staff and student qualitative feedback on the on the VHB has been being sought throughout the project.

RESULTS

Between the release of the pilot on the 14 September 2011 until the end of the semester on 30 November 2011, 74 unique visitors visited the VHB a total of 179 times.

Visits	179
Pages/visit	25
Average time on site	27 min

Table 1. Time on task by platform in 2011.

Most visits were initiated from iPhones (61%), with Windows (21%) and Android-based devices (4%) making up one quarter of unique visitors.

Sixteen students completed the online survey of the pilot. Of these, 13 students (81%) owned a mobile phone that was capable of accessing the internet. Only 4 students used their mobile phone to access the internet daily, and only 2 surveyed students accessed the VHB with their mobile phones.

Informal staff and student feedback pointed to difficulties accessing the VHB with a Windows operated browser, and the need of the VHB to be integrated into the official University of Queensland user authentication protocol, instead of the generic user name and password.

The expended VHB was released on the 22nd of April 2012. It requires the user to follow the official University of Queensland user authentication protocol, and detects the browser accessing the application to automatically scale the screens to suit each particular device. Between the release date and the end of the semester on the 23rd of June 2012, 152 unique visitors visited the expended VHB a total of 384 times.

Visits	384
Pages/visit	52
Average time on site	34 min

Table 2. Time on task by platform in 2012.

During this time in 2012, most visits were initiated from personal computers with a Windows operating system (52%), followed by Macintosh devices (16%) and Linux operated computers (3%). Mobile devices accounted for 29% of all visits. Of those, 80 visits were initiated by Android-based deceives (72% of all mobile device visits), followed by 24 visits initiated by iPhones (22% of all mobile device visits). The remaining mobile device visits originated from iPads and Blackberry devices.

Twenty four students completed the online survey of the extended VHB in 2012. Of these, 20 students (83%) owned a mobile phone capable of accessing the internet. The majority of surveyed students (66%) used their mobile phone to access the internet daily. However, an equal percentage of surveyed students (66%) accessed the VHB using their personal computer. In 2012, only 4 surveyed students accessed the VHB with their mobile phones.

The main reasons students gave for not accessing the VHB with their personal mobile devices were that they did not own an internet-enabled mobile phone, or that they did not wish to use their internet-enabled mobile devices for this learning activity. The surveyed students who did access the VHB with their mobile phone did so mostly via their own ISP. The predominantly identified location at which students accessed the VHB using their mobile devices was their private homes, followed by unspecified locations that allowed students short time frames for learning, for example while "commuting" or "waiting at the doctor's surgery".

All surveyed students in 2012 enjoyed the learning experience. Student feedback specifically praised the useability of the VHB with its uncomplicated, easy to navigate interfaces: over 70% of surveyed students rated the VHB as "very user-friendly". They also agreed that the VHB aided their learning of human physiology, and that the VHB has helped them prepare for the final examination. Over 70% of surveyed students who did access the VHB using their personal computer still agreed with the statement that "Mobile learning applications such as the Virtual Human Body should be more widely used in university courses to aid to learning".

Preliminary analysis of student performance as measured by summative assessment suggests that the number of students receiving a grade of 6 or 7 (on a 1-7 scale; 6 = distinction, 7 = high distinction) increased by 5%, from 40% in 2011 to 45% in 2012. Further analysis including control for cohort variations is underway, and will be presented at the mlearn 2012 conference.

DISCUSSION AND CONCLUSIONS

A little over half of the students accessed the first iteration, primarily from iPhones. The main reasons why students did not access the first iteration were that they either did not own an internet-enabled mobile phone, or did not wish to use their internet-enabled mobile phone for this learning activity, and that conventional Windows-operated browser access from stand-alone personal computers was difficult. Thus, care was taken that the second iteration is easily accessed by devices using multiple operating platforms and systems, including stand-alone personal computers.

Internet traffic statistics reveals a greater uptake of the expanded VHB, principally as a result of improved PC accessibility. However, the unexpected participation of students from other health science courses, although welcomed, do not allow us to measure the increase in participation. Mobile devices were used for almost 30% of all visits, which is similar to the mobile device traffic rate found in our original SBLi™ mobile interface project (Ernst & Harrison, 2012). Interestingly, Android-based devices are now more common among the mobile devices used by students in this project. This may be due to cohort variations, but may also be partly the results of the recent increase of the market share of Android-based devices. According to a recent industry report the market share of Android devices in Australia "has grown … from 32.2% in 2011 to 52% in 2012, while Apple IOS has fallen from 35.6% in 2011 to 35.3%." (Sadauskas, 2012).

About 20% percent of students responded to the online student survey after the pilot in 2011. It was hoped that the new iteration in 2012 would yield a greater survey participation rate as the new iteration itself is now universally accessible, which in turn has encouraged higher uptake rates of this mlearning activity. However, only 15% of students who used the expanded VHB have responded to the online survey. In particular, students who accessed the VHB with their mobile devices are underrepresented in both surveys. Tentative conclusions based on this limited student feedback include that students find the VHB user-friendly, that the VHB supports student learning of health sciences, and that the VHB helps students to prepare for summative assessment. Further, students who only used their personal computer to access the VHB still perceive mobile learning applications such as the VHB as a desirable and beneficial university course component.

We reaffirm that in the mobile learning environment, both the curriculum, and the technologies that support that curriculum, are iterative. The back end of the original SBLI^{TM} mobile interface was too maladaptive, forcing us to recognise the principle of platform ubiquity. This meant our learning activities needed to be scalable in order to be universally accessible. For instance, the current VHB version has two different types of video file for the same video content – one for mobile devices, the other for computers.

This is not a problem unique to mobile learning activities. In recent years traditional television broadcasters have had to shift to new viewing modes. In the process, they have discovered the need to scale their outputs for delivery on devices ranging in size from mobile phones to stadia screens (Zhou, 2012). Together, this convinces us of the benefit associated with the utilisation of a web-based design system that allows the leverage of diverse but student-owned technology for academic benefit. This permits simple and easy adaption to new technologies, while literally providing a template for curriculum innovation, in terms of both flexibility of delivery, and dissemination to other curricula.

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Serious games at the UNHCR with ARLearn, a toolkit for mobile and virtual reality applications

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ABSTRACT

This article presents experiences and lessons learned with the implementation of a serious game for simulating the management of a hostage taking scenario. The game was created with ARLearn, a toolkit for mobile and virtual reality serious games, developed at the Open University of the Netherlands. In collaboration with the United Nations Refugee Agency (UNHCR), ARLearn use cases for crisis situations were developed. This manuscript covers the games that were designed with UNHCR's Global Learning Centre (GLC) and discusses the training pilot with UNHCR staff-members.

Author Keywords

Serious games, mobile learning, field-trips, security simulation

INTRODUCTION

To better protect and meet the needs of forcibly displaced persons, humanitarian agencies like UNHCR must be able to make use of new technologies to train its staff on a number of key subject areas such as refugee law, international human rights law, international humanitarian law, operations planning and programmes and security risk management. Some of these subjects can be delivered through more "traditional" eLearning delivery methodologies such as self-study eLearning and webinar-based coaching. Training humanitarian staff on complex subject areas, such as managing hostage taking situations, however rely more on immersive and participatory simulation exercises and role-plays. These methodologies are typically used for security and emergency training exercises at UNHCR where creating a realistic environment during the training is key in delivering the learning objectives thus ensuring that the participants respond effectively in similar real-life scenarios.

Simulations are used by the security training team at UNHCR's Global Learning Centre to evaluate the effectiveness of plans and procedures designed to respond to security threats by testing them in a series of simulated threat scenarios.

Organizing real-life security simulations can be resource heavy, and often involves the use of weapons, explosives, large crowds and vehicles. As the purpose of these exercises is to identify any significant deficiencies in the protective strategy that need correcting, the use of mobile devices can replace some of these resources without losing the realistic effect, thereby making it more flexible and easy to implement. In addition, in many environments in which UNHCR operates, a real-life simulation is impractical or impossible to carry out due to the high risk it presents to staff. In some cases, it is simply not safe to conduct large-scale simulations. In other environments, host governments would not be favourable to such an exercise taking place. In these situations, mobile devices allow UNHCR to practice security plans and procedures in an effective manner, without risking the reputation and relationship between UNHCR and host governments and as well as minimizing personal safety risks to staff. As such, using simulations with mobile devices saves time and money, and ultimately helps to save lives.

Towards this objective, the OUNL and UNHCR have decided to collaboratively develop and train UNHCR staff with the ARLearn application (ARLearn, 2012). ARLearn is an open source mixed reality application framework (Milgram, 1994) (Liestøl, 2011), which supports mobile applications for Android smartphones. With this toolset, learners are presented audio-visual information based on triggers like their location and responses to questions. Furthermore, it enables learners to take notes (with audio or pictures) and by doing so build an online portfolio. The application has been deployed in different educational scenarios in which learners are to explore their environment and collect data, commonly addressed by the concept of fieldwork (Ternier et al., 2012).

EDUCATIONAL SETTING AND THE DESIGN OF A MOBILE GAME

UNHCR operates in over 120 countries, its staff often work in hazardous locations. To better equip staff, UNHCR conducts a number of security management trainings worldwide. These trainings are organized by the Global Learning Centre (GLC) of the UNHCR based in Budapest. The typical approach is a workshop organized over a 3-5 day period in which different aspects of security risk management are addressed. These workshops cover policy based information, such as standard operating procedures, delivered through self-study pre-Elearning modules follow by instructor-led workshops. The workshop also includes immersive simulation exercises, for example hostage taking, bomb threat and other security-related scenarios.

For many years a role-playing game has been part of these workshops. In this game learners are split into groups representing the different roles that are present in an actual security situation. The groups have to implement and carry out the procedures that have been introduced during the pre-Elearning modules and the workshop. In the case of the hostage-taking scenario, a role-playing game is a highly immersive experience for the learners, in which they have to deal with stress, act quickly, collaborate and negotiate in order to 'save the hostage'. Running the game turns out to be an intensive exercise, not only for the participants, but also for the organizers and facilitators. It requires a lot of concentration and effort by a facilitator to encourage the whole team to engage in the chaotic development of a hostage situation, with the limitation that there is a maximum number of participants that can effectively join a game. As the game is carried out at a rapid pace it can be difficult to have an all-inclusive debriefing in which all roles of all teams receive appropriate feedback. The debriefing and reflection phase of the activity is a major learning point. Debriefing allows learners to reflect on what they learned, the challenges and risks associated with hostage taking situations and their personal capabilities. Facilitators recognize that this is one of the most important learning moments, however it is difficult to capture all the important points from the simulation due to the speed at which events occur. This aspect has led to the development of this project, in an effort to address this shortcoming.

As an alternative for the original game, a version was developed applying concepts of mobile serious games and blended instructional design principles (Gruber, 2010). Using the ARLearn toolkit made it possible to address the following training issues:

- Enabling the creation of different reusable variations of a game-design for emergency security response, covering initially the hostage taking situation and potentially other cases.
- Enabling 'on the fly' messaging to participants and real-time assessments of activities.
- Semi-automatic management of the game thus enabling more participants to experience the role-playing exercise.
- Creating a log through the game of responses and interactions, which can be used by the trainer to provide feedback during the debriefing session.

In the following paragraph the functionalities and technical capabilities of ARLearn will be described after which the actual game designed is to be discussed and evaluated.

ARLEARN

ARLearn, originally a tool for audio augmented reality, has grown over the past few years from a standalone smartphone app to a fully-fledged mixed reality application platform taking into account field-trips, serious gaming, augmented virtuality and a notification system (Ternier, 2012). ARLearn features two important concept that enable the design of reusable mobile serious games.

1. A game is a blueprint for a simulation or a field-trip. Within a game media items, progress rules, scoring rules and dependencies between items are bundled. A game defines a configuration and captures whether scoring is enabled, whether a map view is enabled, etc.
2. A run is a materialization of a game. A game can be played multiple times through the creation of new runs. A run defines teams, users and assigns roles to the users.

At design time, the various artefacts such as open questions, audio messages, movies and multiple-choice questions are defined. Depending on the actions a user takes, the ARLearn system can be configured to hide or display new messages.

UNHCR CASE STUDY – GAME DESIGN

The first ARLearn pilot was implemented in UNHCR at the Security Management Learning Programme (SMLP) workshop in December 2011 in Entebbe, Uganda. The 17 participants were senior staff members, including heads of offices, who are responsible for managing operations and the security of the staff members in their country offices.

A pre-game survey was conducted to examine how comfortable the participants are with smartphones. The majority use their mobile phone frequently, either constantly (9/17) or daily (6/17). Eleven participants use their phone to access the internet/email. Six of them constantly access the Internet with their smartphone. This survey shows that most of the participants were comfortable with a smartphone, although most of them had not used a touch-screen based device prior to the simulation.

The workshop was organized in the conference room of a hotel in Entebbe. Internet connectivity was limited and sporadic, and electricity cuts were quite frequent. In Entebbe, the game was played using 9 smartphones simultaneously. Three runs were created for the game, with 3 roles participating in each run. Each role was assigned 2-3 players.

The game is designed to prepare the participants on the response procedures to be initiated immediately when a staff member is taken hostage. A Hostage Incident Management (HIM) team is deployed eventually in such situations but it can take time till this team arrives and offices need to know how to respond prior to their arrival.

The players participated in this game taking one of the following three roles: head of office, security officer and staff welfare member. The hostage-taking simulation was designed such that players in all roles play the same game but have to react differently based on their roles. The game is organized in 5 phases:

Phase 1: Notification of the incident

The game starts with a plea for help by Jerry Khan, a fictitious UNHCR employee that was taken hostage. This video message features a blindfolded actor and creates an authentic context. This message is broadcasted to all the roles. Next, players take a decision on what to do next, depending on their specific role. The head of office (role A) for instance can decide to "notify the Designated Officer (DO)" while a staff welfare member (role C) should select the option to "contact senior management". Depending on the decision taken, they receive feedback on whether this is a good choice.

Phase 2: Assembling the team

In the next phase, the head of office is informed by the DO that a hostage incident management team will be dispatched. In the mean time, they need to contact the security advisor (role B) and staff welfare officer (role C) and ask them to assemble in headquarters for a planning session.

Phase 3: Planning

When the facilitator observes that the team has assembled, an audio recording of the DO requesting the team to work out a reception plan is sent out. The team is next tasked to work out this plan on a flip-board and to capture a photo of the plan with their device and submit this as soon as they are ready. Next, the participants are asked to split up and go to their individual rooms.

Phase 4: Responding

In this phase, role A and role C participants are to respond to calls from a journalist and a distressed family member respectively. The security officer (role B) in the meantime receives a message from the DO with the task to prepare a Proof of Life (POL) question.

Phase 5: Negotiating

In this last phase, all roles gather together again. This is triggered by a message from the hostage takers. In this phase, a negotiation with the hostage takers is simulated. The game ends with the message that the Hostage Incident Management (HIM) team has arrived and is ready to take over the negotiations.

UNHCR CASE STUDY – RESULTS & CHALLENGES

Overall, the game was well received and the participants were able to successfully complete the runs. During the run, there were three electricity cuts that caused the wireless router to reset. However, the participants were able to continue the exercise despite these challenges as ARLearn caches both game content and logic on the mobile devices.

The participants found the ARLearn simulation very useful, and once they got over the initial technical obstacles were able to respond to the Notification, Assembling, Planning, Responding and Negotiating exercises. From the 17 participants, 14 answered positively on the question regarding the usefulness of mobile phones in a simulation exercise (1 was negative, 2 had a mixed response). As both the exercise and the use of smartphones was new to the participants, the expressed learning outcomes varied from 14 persons learning from the game itself to 2 people expressing that they mainly learned about using the smartphone and 1 reported no learning.

From a content perspective, the participants were able to understand the criticality of the exercise and the tasks associated with the immediate response of a hostage taking scenario. They learned the importance of coordination that was enabled and assessed through the game. The game added more realism through the "Jerry Khan" hostage video, calls from distressed family members, and pressure that was applied by the demands of the hostage takers. In addition, the facilitators played a role in moderating and pacing the flow of the game through the use of the manual triggers. It created good role inter-dependencies and showed that the leadership of the head of office (role A) plays a key role in ensuring that the team delivers.

There were also some surprising outcomes, with participants realising the importance of efficient and rapid information sharing in a crisis that is enabled through well connected and ICT-enabled offices. Participants also found the exercise highly stimulating, as they played the game within the device, moved around, interacted with each other and responded to the various assessments. The learning from the ARLearn exercise was later referred to in the workshop, for example on the formation of the proof of life (POL) questions.

There were a number of technical challenges with the exercise, especially related to the problems of dependence on the wireless internet. The live internet enables :

- *Role inter-dependencies*. When a player takes an action this can cause messages to appear on an other player's device.

- Manual triggers. The game facilitator can use the console to make a message appear on all devices.

These functions require the devices to be constantly connected to the network. The participants were also uneasy initially with the devices, and the initial challenges were more related to the usability of the device than the game itself. As the participants got more comfortable with the device they were able to focus on the real objectives of the exercise.

CONCLUSION

Hostage taking was selected as a pilot due to the complexity of managing such an event. Albeit relatively low in frequency, the impact of an abduction is extremely high. Although the rate of kidnapping per year varies significantly, the average numbers of kidnappings of humanitarian workers from 2006-2008 represents a 250% increase over the previous 8 years' average. In Somalia alone, 50 humanitarian staff were taken hostage from July 2008 to December 2009. Based on this trend, hostage taking and abduction is clearly a topic the organization should be well prepared to respond to and manage.

The ARLearn tool has proved to be useful in aiding the "realism" of UNHCR's hostage taking simulation exercises. UNHCR's security training team plans to implement further security scenarios in 2012-13 with the tool including but not limited to:

- Death of a staff member
- Car accident involving injuries
- Kidnapping of a staff member (terrorist, politically or financially motivated)
- Refugee threatening suicide
- Staff member injured in mine strike that occurs with a team on mission in a remote location
- Angry demonstration that turns into a riot outside the office
- Staff member(s) detained in a refugee camp by a group of angry refugees
- Arrest of a staff member
- Bomb blast on the street outside the office – gate destroyed and casualties among guards but no major damage to the office itself
- Loss of the office

Beyond security training, UNHCR also plans to use the ARLearn tool to train on scenarios in the field of emergency response, refugee protection and programme management.

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Developing electronic classroom response apps for a wide variety of mobile devices – Lessons learned from the PINGO project

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ABSTRACT

Classroom response systems (CRSs) have proven to turn students into active participants in lectures. Thus, these systems help to improve the students' learning performance in traditional head-on lectures. Peer Instruction is a teaching and learning approach that makes very specific use of Classroom Response Systems elements: similar to the ask-the-audience lifeline in *Who Wants to Be a Millionaire?*, students get involved in the lecture by using clickers to answer multiple-choice questions posed by the instructor. Depending on the answer distribution the students are encouraged to discuss their answers with their peers. After some time of peer discussion the instructor poses the question again. In our efforts to develop a web-based application to support Peer Instruction in very large groups, we have faced several issues that we did not take into consideration in the initial design phase of the application. In this paper we share some lessons learned from the development process and report about some oddities found.

Author Keywords

classroom response systems, mobile development, lessons learned, development issues, platform independence, peer instruction

INTRODUCTION

Many researchers have concluded that the traditional head-on lecture-style courses contribute only little to the students' understanding of central concepts in their respective domains (e.g., Bleichner et al. 2000; Crouch et al. 2007). At the same time, it is commonly agreed upon that students will develop complex reasoning skills most efficiently when they actively participate in the subject matter (e.g., Crouch et al. 2001; Hake 1998). Thus, active participation fosters the students' learning process much better than traditional head-on lectures. So-called *Classroom Response Systems* (CRSs) are one way to motivate students in active participation in the lectures. A CRS enables instructors to pose questions in learning settings and supports them in gathering immediate feedback from the students. Researchers from various research domains have extensively documented the benefits of CRS (Fies and Marshall 2006; Roschelle et al. 2004).

Over the past years, many technology-enhanced CRSs have been developed that allow students to cast their votes using so-called *clickers*. The main advantages of such electronic CRSs over non-technical methods are the possible anonymity of responses (Draper and Brown 2004), the ability to immediately visualize response graphs for the class, as well as durability and extended means of data analysis. Since electronic CRSs also result in higher acceptance rates compared with conventional ones (Stowell and Nelson 2007), most instructors now rely on electronic systems in their classes (e.g., Cleary 2008).

One specific teaching approach that makes use of the prominent CRS elements is Peer Instruction (PI). PI (Mazur 1997a) is a cooperative teaching and learning approach that is well suited to involve students even in large auditoriums. PI is technically similar to the ask-the-audience lifeline in *Who Wants to Be a Millionaire?*; students get involved in the lecture by using (physical or electronic) clickers to answer multiple-choice questions posed by the instructor. The questions are designed to motivate students and to unveil potential difficulties with the course topics and material. If the questions are not answered correctly, the course participants are encouraged to discuss their answers with their close peers or the presentation is repeated in a modified way (depending on the percentage of wrong answers). The motivational and learning benefits of PI have been shown and reproduced in many empirical studies using varying methods (e.g., Crouch and Mazur 2001; Crouch et al. 2007; Fies and Marshall 2006). However, until today, PI has been rarely used in very large groups, i.e., groups of (far) more than 350 students. One major reason for the comparably slow dissemination of PI is the expensive infrastructure for electronic CRS that is mostly driven by physical clickers and/or software licensing fees. When electronic clickers applications are used, they are often limited to one operating system, only work with a limited number of participating clients or are hard to use (Stuart et al., 2004; Herreid, 2006; Lasry, 2008; Salemi 2009; Kundisch et al., 2012). Moreover, there are complaints when students have to buy their own physical clickers (Patry, 2009). To design a technically and didactically favorable environment for the application of PI to very large audiences, we initiated the PINGO (Peer Instruction for very large Groups) project (Kundisch et al. 2012). The goal of the PINGO project is to develop an open, scalable, web-based and easy-to-use PI application for students and instructors.

In this paper we describe challenges in choosing the right platform for developing mobile applications that should be used by a large number of heterogeneous devices. Moreover, we report some oddities that we faced during the development of the web-based mobile application for PINGO. We close the paper with some conclusions that can be drawn from our experience.

CHALLENGES IN DEVELOPING MOBILE APPLICATIONS

When developing an application targeting mobile devices, the development process can be optimized regarding various parameters. In our specific scenario a very broad range of devices should be supported while minimizing the overall development effort. Three options were evaluated:

1. multiple native applications, one per device platform,
2. one multi-platform application and
3. a web-based application.

Building a native application for every supported device was no option at all, because of the huge development effort. The main reason is the diversity of platform specific programming languages, Application Programming Interfaces (APIs) and development tools. For example, source code and know-how from an iOS application written in Objective-C can hardly be transferred to an Android application written in Java.

In order to mitigate the differences between different platforms from the developers' point of view, there was the option to use a cross-platform-framework like Appcelerator Titanium[1] or PhoneGap[2]. Thereby a platform agnostic set of programming language and APIs is used, which is provided by the framework. In the end, there is conversion step, which creates platform specific applications based on only one code base. The drawback of this option is that the generalization of platform-specific APIs is only achieved only up to a certain point. For example, some well-known UI widgets are only available on one specific platform. If a developer wants to use such widgets, platform-specific code is needed. Appcelerator Titanium, for example, provides much platform-specific functionality at platform-specific namespaces. This enables a developer to make an application as native as possible but, at the same time, produces platform specific code, which had to be avoided with respect to the development effort.

Both options of developing an application for mobile devices have in common that they need some kind of a deployment infrastructure (e.g., the Apple App Store or Google Play). Such an infrastructure introduces issues, like delayed delivery of a new application version or rejection of an application by the infrastructure provider. Besides, supporting a broad range of mobile devices includes devices such as windows or Linux based laptops or tablets as well. However, these devices are supported by neither mobile cross-platform-frameworks nor the well-known deployment infrastructures.

Therefore, we decided to build a web-based application. From our point of view, this approach reaches the most devices and operating systems while minimizing development efforts. This approach is achievable because an increasing number of mobile devices integrate powerful web browsers, capable of technologies like JavaScript, CSS and HTML. Thus, it is rather unproblematic to run feature-rich web-based applications on these devices. Moreover, a web browser provides a platform agnostic runtime environment, eliminating the use of platform specific APIs. Also, no deployment infrastructure is needed. The user only has to enter a known URL into the device's browser or scan a given QR code.

ODDITIES OF WEB-BASED APPLICATIONS ON MOBILE DEVICES

When developing web-based applications, the browser determines the range of functions available to the application. That means that only technologies provided by all browsers on all devices that should be supported can be used by the application. Thus, the choice of which devices to support has a great influence on the usable technologies, because the 'weakest' device is decisive.

In the case of PINGO, the devices that determined the usable technologies were those running Android 1.6 or Symbian S60 3rd edition. Despite the widespread proliferation of latest smartphones, netbooks, and tablets, many of the mobile devices owned by university students still run these operating systems. Therefore, mobile web frameworks like jQuery

[1] http://www.appcelerator.com/

[2] http://phonegap.com/

mobile[3] or Dojo Mobile[4] could not be used, because the named devices lacked sufficient CSS support. Trying to circumvent missing CSS features with more mature web development approaches, such as tables and images, does not work in every case either. For example, replacing a CSS animated spinning wheel with an animated GIF image does not work on Android 1.6 because there is no support for animated GIF images.

Moreover, a web-based application cannot control the mobile device as much as native applications can do. For example, a change of the device's power state (e.g., to suspend or standby) cannot be interrupted by a web-based application. It cannot even be handled prior to its occurrence. The execution of the application will simply be stopped. This is problematic in case of timing-sensitive tasks, for example for periodic heartbeats sent by the client to indicate its presence. In our specific scenario, persistent Socket.IO[5] connections between the application and the backend collapsed due to the fact that the backend expected the client to be gone because it received no more heartbeats after the client device changed its power state. Even more problematically, after changing its power state back to active the device expects the persistent connection still to be fully functional. This results in client messages sent to the backend, which are silently being dropped because the backend has already closed the connection.

These cases can be identified by the developed application by using some sort of periodically timed, heuristic checks. However, these heuristics do not indicate a change of the device's power state in every case. A better alternative is to work without persistent connections at all and use stateless communication patterns, such as HTTP-REST.

As web-based applications cannot be tested with each and any targeted mobile device prior to deployment, the backend has to validate the consistency with respect to the agreed patterns for each message from the client. While developing PINGO, unchecked client messages broke the backend several times because some client devices did not behave as expected. When deploying a web-based application, one cannot trust the executing device to behave correctly. For example, there may occur some unexpected problems if the user disables JavaScript execution or prohibits client-side storage.

Incompatibilities between different mobile browsers have to be handled as well. This problem is not as crucial as on the desktop side, because of the dominance of WebKit-based mobile browsers. Nevertheless, a web-based application may not work as expected when started on a non-WebKit browser, such as Microsoft's mobile Internet Explorer (IE). For example, using the well-known JavaScript function console.log will silently break a web-based application on mobile IE because this function does not exist in mobile IE's JavaScript context.

CONCLUSION AND RESEARCH OPPORTUNITIES

Based on our work on developing a web-based application to support Peer Instruction in very large groups, in this paper we have discussed general challenges that have to be dealt with when developing mobile applications. We outlined that the development has to take into consideration the specifics of the devices to be supported and how they determine which application framework and technology may be used. We found that cross-platform-frameworks like PhoneGap or Appcelerator Titanium may be well suited to develop simple applications that merely present web-based content. If native functions of the targeted operating system shall be used, knowledge in the respective programming languages is needed. Thus, we have decided to develop the mobile application for the PINGO project using handcrafted HTML and CSS as it seemed to be the most cost- and time-efficient approach. During the development we found several oddities that we reported in the above section.

Our first prototypes are now used in practical evaluations in courses in business information systems (1000+ students enrolled), teaching and learning (500+ students) and computer science education (20+ students). So far, the students gave very favourable feedback for both the general idea of a low-cost, universally usable Peer Instruction application and the mobile application in particular.

The course in business information systems was an ideal candidate to evaluate the prototype as there were more than 1,000 enrolled students and 95% of these students possessed one or more web-enabled devices. Amongst others we used the Technology Acceptance Model (Davis et al. 1989) to evaluate the PINGO application. The average perceived ease of use among the 438 respondents was evaluated with 6.22 out of 7. The average perceived usefulness was evaluated with 4.93, the average attitude towards using with 5.49 and the average behavioral intention to use with 5.70 (see more detailed information on the evaluation in Kundisch et al. 2012; Reinhardt et al. 2012). All of these results are a strong positive indicator for the future usage of the system.

We will continue to improve the overall design of our application using the early feedback from the prospective users and make the PINGO application framework open source after maturing all parts of the infrastructure.

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[3] http://jquerymobile.com/

[4] http://dojotoolkit.org/features/mobile

[5] http://socket.io/

Finally, we want to give some advice to developers of mobile learning applications that target a very large number of parallel users:

- always develop with the 'weakest' device in mind (hint: a web-based application that runs on Android 1.6 will run almost everywhere else as well),
- prefer stateless communication over persistent connections,
- test your application on as many different mobile devices as possible,
- when you rely on message-based communication between client and server, make sure that you check each client message, as you cannot trust the client.

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The Magic Door: Smart Interactions between Students and Lecturers using Contactless Technologies

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ABSTRACT

In this paper we describe an information system designed to simplify the interactions which occur frequently between students and lecturers within a Higher Education environment. The concept focuses on utilizing both objects in the physical world and online services to create new experiences to support flexible learning for educational settings. With the opportunities offered by Radio Frequency Identification (RFID) / Near Field Communication (NFC) technologies, tags can be used to identify and perform interactions between users. The system allows for the timetabling of meetings, delivery of messages and course announcements between the students and lecturers. The objective is to eliminate the problems which are encountered when arranging appointments or convening with students. By placing the responsibility of booking appointments in the hands of students using their mobile devices; the system aims to provide an interactive and ubiquitous support technology for both student and faculty members.

Author Keywords

Information Retrieval; Ubiquitous Information System; Mobile; Near Field Communications; RFID Tags; QR Code

INTRODUCTION

With the emergence of RFID technology, mobile devices and increasing network availability; physically-based user interfaces have become a possibility for augmenting everyday interactions. Ubiquitous computing technologies are finding their way into commercial information systems. The London underground and its Oyster Card system (Transport for London, 2012) is an example of a large scale RFID deployment which has simplified users commutes (Konomi et al, 2007). There are commercially available products such as 'Tikitag' (Reid, 2008) consisting of a small USB scanner, rather like the Oyster readers, enabling the use of RFID wireless technology to link any type of offline device such as a sticker or a tag with information online. This includes web pages, web applications or rich online media such as video.

This technology has been demonstrated to produce an improvement in motivation and at the same time a reduction of cognitive demands for learning by information retrieval (Manches et al., 2011). With the current and future climate in further education meaning that students expect continual support, the concept of 'office hours' and supporting learning is important for sustaining the students' engagement with their courses. Delivering information to mobile devices from central information systems, such as virtual learning environments (VLE) and learning management systems (LMS) to support student engagement have been previously explored with positive outcomes (Crane et al.,2012). Furthermore, studies into mobile organization systems within learning environments like have also been investigated with students, (Corlett et al,2005.) with scheduling becoming a major function of the users activity.

Interaction between students and lecturers is one of rising importance with the increase in tuition fees, student's expectations have increased (Littlemore, 2011); requiring a higher level of interaction and an increase in face to face time with their supervisors and lecturers. Distinctly, this problem is two sided with lecturers also suffering from a lack of support when organizing appointments with students. Methods of coordinating such activities resort to post it notes or reminders, as a method of informing students of their schedule and location. Systems such as the Hermes (Cheverst, 2002) have been used in the past, but are costly to install and therefore are of limited availability.

The concept of the project is to create a solution to support course supervisors and students concurrently by positioning an interactive smart poster on the academics office door. By definition, a door in the physical world is "a means of access, admission, or exit"; it can also provide a means of access to virtual areas. By creating virtual interactivity with commonplace physical objects, the hope is to optimize the current system, and sustain student engagement with their courses. The solution would act as an add-on service in order to encourage access to an online diary and information on demand. These micro interactions ideally would be used to leave a small notes/reminders or for students to have a quick access link to retrieve the educator's availability.

This system demonstrates methods of solving the communication problems using a set of low cost NFC tags that can be scanned by a student and which will then update them with the comings and goings of the lecturer whose tag is scanned. The student can use RFID tags to book a slot to meet with the lecturer, leave a message or simply check up on any announcement that has been left. In addition we have added a series of QR codes, providing an alternative method to access the same service for those students who will not have NFC-enabled smart phones. Also, cheap commercial devices are appearing as alternative to mobile phones. Poken allows users to collect people, places and things with a touch (Poken, 2012). All these available products enable different solutions to existing problems for a range of various sectors and industries. Within an educational field, the organization and efficiency of activities can be increased. One example which is explored by this paper is the affixing of RFID tags onto the office door of a lecturer, to consequently; reduce the cognitive demands on the user by associating that lecturer with his room instead of using complex web portal software or calendar software. The user would be able to interact directly using such devices, creating new methods of communication between faculty and students.

NFC CONNECTIVTY & INTERACTION

When computers were first conceived, interaction with these devices was performed via abstract but fairly intuitive methods. For example, the computer mouse requires the user to translate movement on the horizontal physical plane to the vertical plane seen on their monitor. These usage abstractions have now extended to all aspects of the way in which we use these virtual environments. Rather than physically visiting a person or sending a message directly to them we now interact with an email address rather than an actual person. Paul from the university can now be identified as paul@lancaster.ac.uk. These abstractions increase the cognitive demands required by the user to interact with already complex systems.

People naturally think of these systems in physical terms and as such designers have tried to design interfaces with real world analogue. Email has been compared to sending letters; Skype is akin to the ‘phone network and File managers imitate folders and documents in an actual filing cabinet. Similarly, when communicating directly using other devices, actions in multiple scenarios can be described as Near Physical Interactions (Nandwani et al, 2010). Being able to transfer information from one person to another by simply touching each other’s phone or a tag related to someone, allows for this near physical sensation. The tactile and haptic nature of ‘tapping’, becomes an informal approach yet meaningful and direct.

Informative Things (Barret et al, 1998) takes this approach further by mapping physical objects to a unique ID. This ID can then serve as a look-up key for a piece of arbitrary information. This system closely follows the idea of hotel keys or identification badges where the cards and keys are physical items that represent other data and are attached to a specific room or person. With the Informative Things system physical objects such as a book or floppy disc can be linked to documents or processes. For example a dictionary could be used to look up the meaning of a highlighted word or the physical hard copy of a document could be used to move the digital copy of the same document, transferring it between PCs. We can apply this concept to modern technologies and use mobile phones, follow a very similar system architecture and logic of managing data. Figure 1 and 2 show how we adapted Informative Things to develop the magic door architecture system.

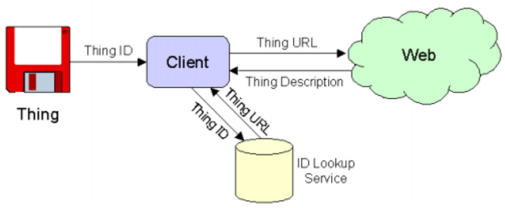

Figure 1. Informative Things

Figure 2. Magic Door Concept

The earlier methods of interacting with physical objects can become extremely complicated. There may be difficulties with passwords, IP addresses, and human error in copying data and spelling errors. Human error is the greatest problem which could lead to loss of data or breach of security and methods had to be developed that would reduce this risk. The Informative Things approach avoids these problems by reducing the concepts into more easily understandable ideas. However this approach requires intensive set-up and has large security concerns. If a physical item mapped with a unique ID, is lost, then the digital item is also lost. Using the physical ID on the doors by using tags, it ensures that whatever device a user may be using they can identify themselves easily.

Others, such as Want and Fiskin have expanded on this concept to bridge the physical and virtual with the use of RFID and wireless networking to create seamless interaction with electronic services (Want et al, 1999) .These approaches improve on Barret and Maglio by allowing for multiple interface mechanisms on one physical object. Their systems are unobtrusive as tags are small and essentially invisible unlike bar codes and other glyphs. One key point of their research is their work on location and tagging items such as tables or doorways to induce context into information systems.

Near field communication (NFC) is a wireless connectivity technology that allows embedded NFC chips to send encrypted data over a short distance to a reader. It was co-developed by NXP Semiconductors and Sony in 2002 and is being added to mobile smartphones for use in mobile payment, data sharing and other applications.

Radio-Frequency Identification (RFID) technologies such as NFC, send radio waves to passive electronic tags to power them and receive a return signal. RFID was first patented in 1983 and in 2006 the Nokia 6131 was the first NFC capable mobile phone. More recent devices include the Nokia C7 and the Samsung Nexus S.

Data can theoretically be transmitted up to 20cm but the practical distance is about a couple of centimeters. As NFC uses a single frequency multiple tags cannot be read at one time and most devices either pick the strongest signal or throw some form of error. The main advantage of NFC over other communication technologies is that NFC does not require any setup. Unlike Bluetooth or WiFi the device does not need any pairing or security setting to communicate with the target. A wave or touch can establish an NFC connection.

THE PROPOSED PROTOTYPE SYSTEM

Figure 2 shows an enhanced approach as a block diagram using NFC. The system proposed, constructed and described uses a Smart Poster containing a series of RFID Tags and alternative QR codes to create the gateway access point to the service. A NFC-enabled phone will be the only requirement to access the services of this magic door. The user would tap a tag, and this would automatically display required information in there screen. The system allows the user to add appointments or send a direct message. A second user could access the services instantly sequentially as a "Tap & Go" action.

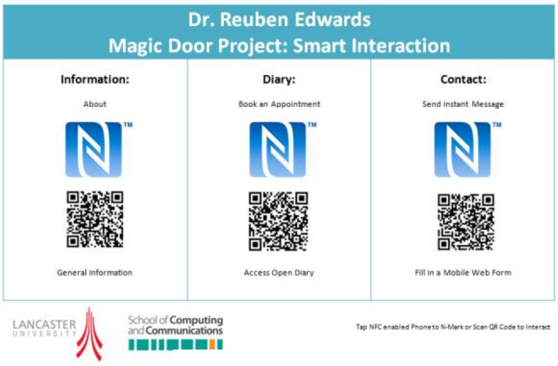

Figure 3. Magic Door Smart Poster

Figure 4. RFID Sticker placed behind N-Mark in Smart Poster (1 of 3)

Figure 3 illustrates the Smart Poster developed for the Magic Door System. It has been split into 3 sections: information about lecturer; a link to an open diary; and a direct messaging service. This allows users a clear, simple and intuitive approach to a lecturer. NFC enabled stickers (Figure 4) have been placed on the reverse side of the poster, mapping the N-Marks, the industry standard logo and universal symbol to identify NFC (NFC Forum). Also, considering the early stage in the deployment and availability of the technology to the end consumers, an alternative has been added to the system using QR codes to access the same solutions with any smart phone. The main difference being, QR codes have to be generated for a specific location, the code redirects users to a website, can take more time and an application is required. Also, these are less effective depending on lighting and users ability to scan the code. The tag just needs to be touched, and contains more meaningful information, and cannot not be marred or damaged and would work in any conditions such as in a dark room. Figure 5 shows a student using the system. That simple touch launches a mobile display in the students phone. Figure 6 illustrates an example of a users phone display after tapping the diary tag or scanning its QR Code.

Figure 5. Student Interacting with Door

Figure 6. Booking an appointment with a lecturer through Magic Door

From a single tap, the diary is launched presenting the user at the current day. Available slots are blank and can be accessed. Clicking on the specific slot required would then display an entry form which the student can fill, specifying a title, description of the meeting, location and time. Once the appointment is saved, the lecturer is notified and it is noted on his/her diary. Similarly if the user decides to contact the lecturer, the same process is followed, but in this case emails are sent or the tag would enable for other messaging services such as a SMS through a safe gateway.

The system improves in many aspects the current interactions by allowing an instant feedback functionality which generates time saving to students and lectures; by not having to write, wait and respond to emails. It also enables the students to physically interact with a lecturer even if he is not present, giving him/her the opportunity to manage the appointment. It is easy to use and intuitive, the implementation costs are very cheap and there is no installation required.

The lectures can manage the tags and QR codes to display what they prefer and adapt the poster to their needs. This solution would compliment what is currently provided in higher education environments and holds the potential to be developed and expanded into more complex services such as declaring attendance or tracking student's interactions with analytics. Real-time interaction mechanisms and similar technologies in education exist. (Hwang et al, 2011). These technological developments relate to existing e-libraries libraries (Chu et al 2010) and Museum guides (Chiou, 2010).

CONCLUSIONS

We propose a prototype system that enables a new way to interact and communicate with lecturers using mobile phone and emerging contactless technologies generating a learning management system where lecturers do not have to be physically present or respond. The students have the opportunity to make arrangements without direct confirmation of the lecturer. Unlike previous attempts, the system is current and can be deployed now without expensive and time consuming installations. Students are able to deliver and retrieve information in context and the service enhances their experience within the higher education environment. The system supports student's organization of learning by utilizing pervasive mobile technologies and by disseminating information from the central information systems to the user's mobile devices. Lecturers have full control of the system, being able to manage public and private appointments and have a pre-scheduled diary without having to worry to plan their days and meetings with students in advance, solving current common issues in academia. The innovative approach using an actual door to enable interactions with the specific lecturer, the mobility and speed of the process all differ in how students are currently able to engage with their educators. Future work requires the evaluation from both students and faculty into the engagement of the users with the system, although fully operational; the system will be extended across differing departments in preparation for a long term study. The goal of the system is to allow learners another extra way to engage in higher education, collect extra materials/hints and stay motivated. Whilst lecturers have a tool they can customize to their needs and engage with their students with different techniques by allowing doors to act as an extra point of contact to deliver relevant information.

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Enabling discovery of Adaptive Learning Resources for Mobile Learner

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ABSTRACT

The current advancements in mobile and communication technologies provide mobile users with unprecedented possibilities to learn on the move. The diversity in the capabilities of mobile devices as well as needs of mobile learners have, however, created many challenges for learning resource providers. To cope with these diversity problems, many content adaptation techniques have been proposed to adapt learning resources based on learner's needs, preferences, device constraints and usage context. These techniques enable the creation of Adaptive Learning Resources to provide personalized versions of learning resources. The one issue that has not been addressed is the discovery of the potentially most useful version of a learning resource in the adaptive space created by different Adaptive Learning Resources provided by different content providers. Existing search techniques are good enough to discover only static content which has one single version unlike adaptive content. In this paper, we address this challenge by providing an Adaptive Learning Resource Meta-Model (ALRM) to enable mobile learners discover the right Adaptive Learning Resource among the many Adaptive Resources which has the Potential Most Relevant Version (PMRV). We have implemented this model in a prototype application using RDF and used SPARQL query for resource selection.

AUTHOR KEYWORDS

Mobile Learning, Adaptive Mobile Learning, Adaptive Resource Discovery.

1. INTRODUCTION

Mobile Learning is becoming more popular with the increased availability and significant improvement in the capabilities of mobile devices in terms of processing, screen sizes, storage capabilities and network connectivity. The traditional one-size-fit-all approach towards learning resources is not suitable in the mobile learning paradigm, due to the diversity that exists in terms of mobile devices and network connectivity as well as learners' needs. Mobile learning can be more useful if a personalised learning opportunity is provided to learner. Personalised learning can improve the efficiency of the learning process and help the learner take better advantage of the limited time and resource constrained device he has while on the move.

There has been much research in adapting learning resources to the learner's needs and device constraints and it was in the field of adaptive educational hypermedia that first used learners' needs, preferences and background to adapt learning content. When mobile devices improved in specification and could employ multimedia resources, the role of Multimedia Learning Resources in Mobile Learning increased significantly. Universal Multimedia Access (UMA) (Vetro et al., 2003) techniques were used to adapt multimedia content based on the resource constraints of mobile devices.

These content adaptation techniques can provide different versions of the the learning resources which suit different needs and device constraints. This makes adaptive content different from static contents and therefore existing search techniques created to discover static contents cannot be used to discover (a version) of adaptive resources. The challenge of enabling the discovery of the potentially most useful version provided by one of the available Adaptive Learning Resources has not been solved. This potentially most useful version must meet the user's learning needs, is in the right modality and quality to meet the device and battery life constraints and the right duration to meet the time limitations. In this paper, we have addressed this issue by presenting an Adaptive Learning Resource Meta-Model (ALRM) which enables the enables the discovery of the right version among all the versions provided by many adaptive learning resources.

This paper is structured as follows. Section 3 briefly describes the role of Content Adaptation in Mobile Learning and mentions some Content Adaptation techniques. In Section 3, we then describe the concept of discovery of adaptive resource for mobile devices and highlight its importance. Section 4, we describe our proposed Adaptive Content Model and shows how it can support the discovery of adaptive learning resources and finally in, Section 5, we conclude our paper and mention our future work.

2. CONTENT ADAPTATION AND MOBILE LEARNING

The key to the success of accessing learning resources using mobile devices is personalisation and adaptation. Personalisation and adaptation has been addressed by Adaptive Hypermedia (Brusilovsky, 2001) and Content Adaptation (Md Fudzee & Abawajy, 2008) techniques. Adaptive hypermedia deals with adapting content based on user models. User models represent users' preferences and background knowledge. Brusilovsky in (Brusilovsky & Millán, 2007) discusses use of Adaptive Hypermedia and user models in educational systems.

A learning content can be adapted in two ways (Bunt et al., 2007).1) Selection of the most suitable content or information based on user needs and 2) presentation of the selected content to meet the device resource constraints. For example, an-hour long video tutorial for beginner level about a topic can be provided in multiple versions. A shorter version (say 40 minutes) can be provided to a learner who has some existing knowledge about the topic. Moreover, to meet device constraints the video can be delivered in multiple quality levels of high quality, lower quality, or audio or just plain text can also be provided.

Transforming multimedia learning resources in suitable versions in order to be efficiently delivered to meet the diverse needs of learners and mobile devices is a research area that is increasingly attracting a great deal of attention. Adaptive Mobile Learning uses content adaptation techniques to provide multiple personalized versions of the same learning content to meet the challenge of diversity in learners' needs and device constraints.

Qing Tan in (Tan et al., 2011) Proposes a 5R adaptation framework, the aim of which is to provide a learning resource "at the right time, in the right location, through the right device, providing the right contents to the right learner". (Zhao & Okamoto, 2011) discuss some issues arising due to the diversity that exists in learning using mobile devices and address these issues.

Over the years, many techniques and frameworks have been proposed to provide adapted versions of learning resources based on user preferences, devices characteristics and user needs. Some of these techniques can be found in (García et al., 2011; Nguyen et al., 2012; Reveiu et al., 2008; Yang et al., 2007; Zhao et al., 2008).

3. DISOVERY OF ADAPTIVE RESOURCE FOR MOBILE DEVICES

In this section, we introduce a novel concept of discovery of adaptive resources for mobile devices. As mentioned in Section 1, discovery of static content is different from adaptive resources. Static content has one version and can be discovered using existing search techniques. Adaptive Content is different because it does not have one single representation. It can be offered in many different versions varying in terms of both information and presentation. There is a need for a mechanism to enable discovery of adaptive resources. Such mechanism can be based on profiles of adaptive resources which describe all the possible versions of the adaptive resource.

The process of discovery of adaptive resource is shown in Figure-1. It shows that there are three adaptive multimedia resources. Each of the adaptive resources can be adapted and provided in different versions. These versions include adapted video, audio and text versions. A user can use an Adaptive Learning Resource Discovery Service to select an adaptive resource which has Potential Most Relevant Version (PMRV) which is a version that matches user's information needs, preferences and devices capabilities. The discovery service needs to perform the selection based on profiles the adaptive resources.

In a situation where a learner faces battery and time constraints, a learner would like to find a content which meet his learning needs at that particular time and which would consume less battery power. The Adaptive

Learning Resource Meta-Model that we present in this paper enables this process of discovery by enabling search of Adaptive Learning Resource that has a potentially most useful adapted version for a learner.

Recently, (Al-Masri & Mahmoud, 2012) have addressed the issue of discovery of learning resources for mobile device - however they have not addressed adaptive content discovery. The authors present a Mobile Learning Description File (MLDF) through which the mobile learning content provider can specify a set of minimum requirements that a device must possess in order to properly access the content. This enables the learner to select a resource which can be accessible using his or her mobile devices. This mechanism can assist the learner in saving precious time which in turn preserves the battery life of the device. One shortcoming of this approach however, is no inclusion of learning characteristics to meets learner's information needs.

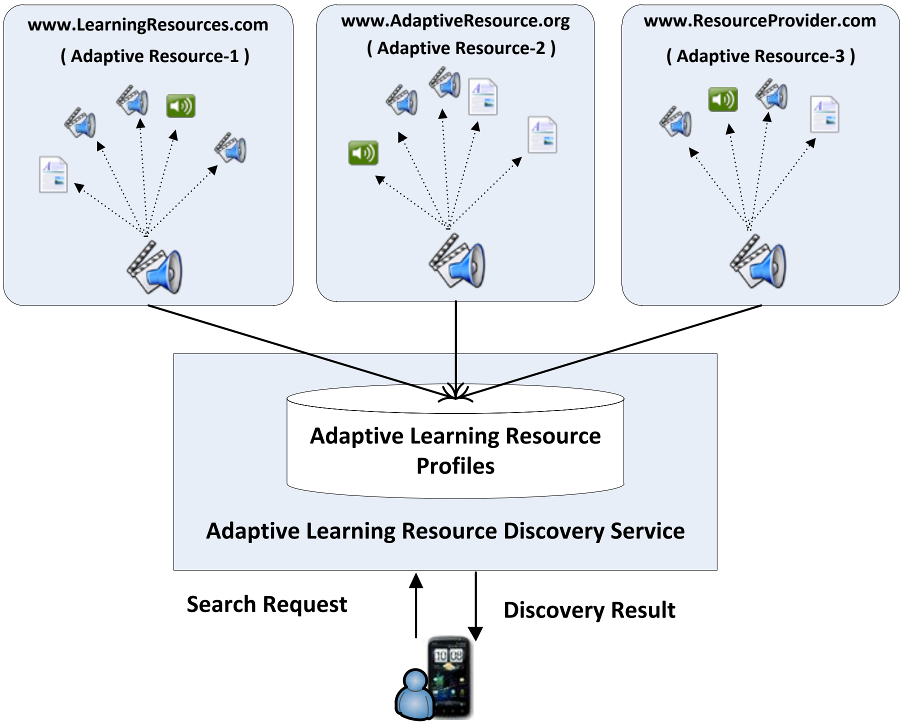

Figure 1: Discovery of Adaptive Resource

4. ADAPTIVE CONTENT MODEL

In this section, we present our Adaptive Content Model, which supports the discovery of the right adaptive learning resource which has a version that matches the learner's need, preferences and device characteristics. We have modelled our proposed model using Ontologies. We implemented our model using Resource Description Framework (RDF). As discussed in section 2 and 3, an adaptive content has many versions. Versions of learning resources vary in features which can be classified as either Presentation Features or Learning Features. Learning Features relate to information needs of mobile learner, while presentation features are related to the device and network characteristics. Learning Features include suitability level in terms of knowledge (Beginner, Intermediate, and Advanced), duration of learning and language. Presentation Features include modality and format of content, resolution and bitrates.

Our Adaptive Learning Resource Meta-Model (ALRM) models adaptive resources in terms of adaptive features. The model is shown in Figure 2. An adaptive learning resource or *LearningContent* has *LearningContentVersion* using *hasVersion* object property. LearningContentVersion will have one instance to represent each version of a learning content. A *LearningContent* has data properties like *identifier*, *subject,* and *creator* to represent URL, topic of learning resource and author of the content, respectively. These features are same to the entire adaptive content and are common to all versions.

LearningContentVersion has *PresentationFeatures* and *LearningFeatures* using *hasPresentationFeatures* and *hasLearningFeature* properties. *PresentationFeatures* represents the presentation of version. Presentation Features includes features like - *Modality*, *BitRate*, *Format*, *Resolution*, *FramesPerSecond*. Modality can be Audio,Video,Text or Image. If the resource is in Audio or Video format than *PresentationFeatures* contains both *BitRate* and *Format* of content. Video content has an extra Feature called *FramesPerSecond*. Image and Video can both have another feature Resolution. *PresentationFeatures* contains one data property which is *dataSize*.

Learning Features includes *duration* and *language* and *hasSuitabilityLevel* data property to link with *KnowledgeLevel*. *KnowledgeLevel* represents the background knowledge of the learner about the same topic, and has instances of Beginner, Intermediate and Advanced using *rdfs:type* property. *Duration* property represents duration of learning resource in minutes and language property represents the language of the learning resource.

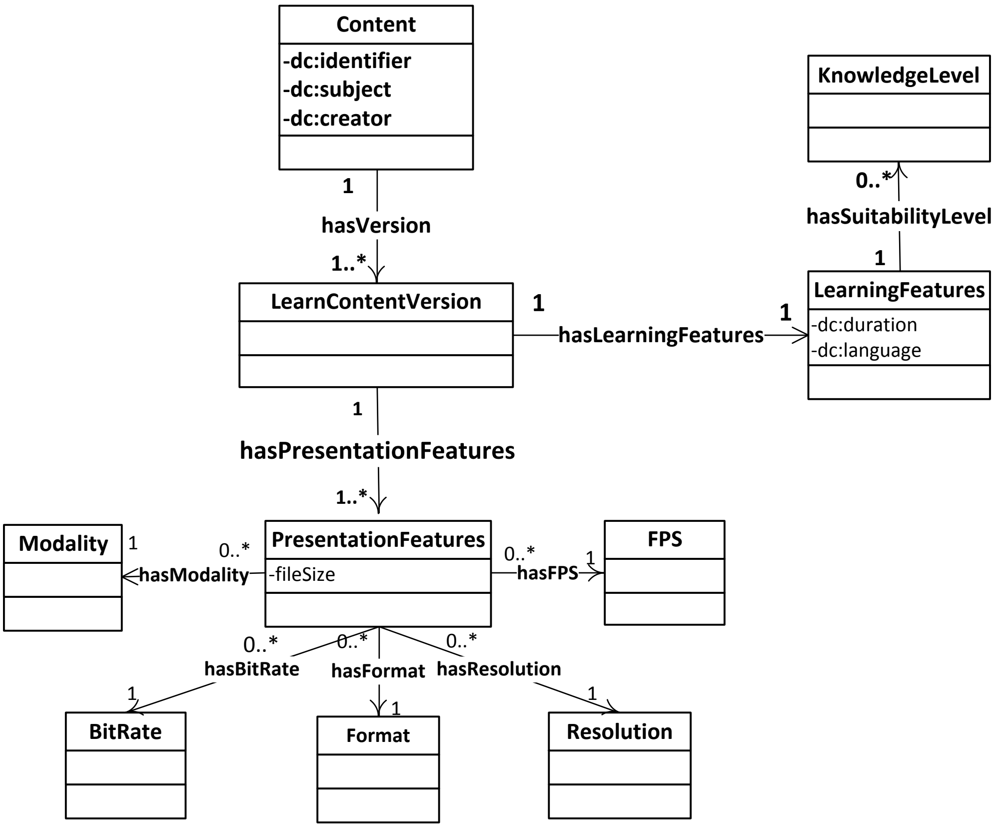

Figure 2: Adaptive Learning Resource Meta-Model (ALRM)

Figure 3, shows a graphical example of an instance of a model for one Adaptive Learning Resource, which is, for example, an adaptive video lecture resource on topic "Semantic Web". The actual discovery query will run across many such models of adaptive resources by different content providers to find the one with most suitable adapted version. We due to space limitation are showing only one model. Figure-3 shows four different versions of this adaptive video lecture resource. We have included only four versions due to the space limitations, in actual system this can be many. Version-1 and Version-3 are Video and Audio versions, respectively, of 50 minutes duration and are suitable for Beginner level. Version-2 and Version-4 are Video and Audio versions, respectively, for Advanced Learners of duration 30 minutes. Version-1 and Version-3 share the same Learning Features while Version-2 and Version-4 share the same Learning Features, while they have different Presentation Features.

Example Scenario:

Bob has a job interview in 40 minutes and is waiting in the waiting area. The job specification mentions preference person having good understanding of semantic web technologies. Bob has some knowledge of semantic web but wants to know more about the topic to improve his chances of success in the interview.

Bob has a mobile phone connected to the internet. He is interested in a tutorial about semantic web technologies in English or French language. He has 30 minutes to learn. By looking at the remaining battery life of his mobile, Bob thinks that video will drain the battery power quickly so he should look for an audio version instead. Bob uses the Adaptive Learning Content Search system, and searches for a tutorial on in Audio suitable for Intermediate level knowledge of 30 minutes duration.

As a result, he receives a link for an adaptive resource that can provide an audio content of 30 minutes duration, which is shorter and Audio version full lecture in English of duration 60 minutes.

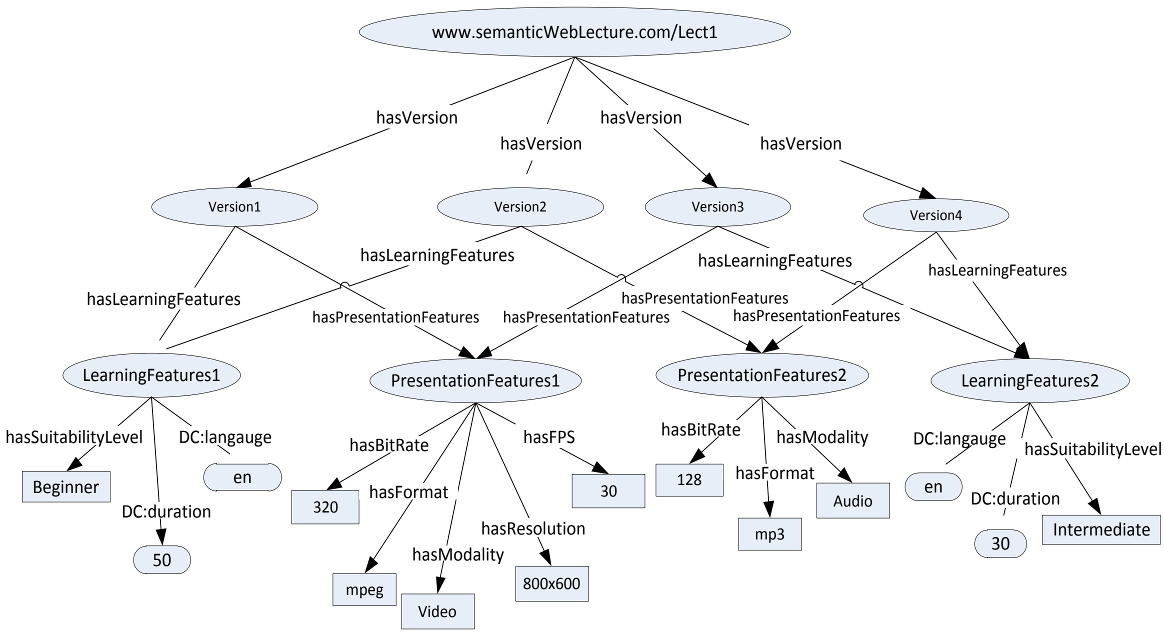

Figure 3: Example of the model

```
PREFIX DC: < http://purl.org/dc/elements/1.1/>
PREFIX ALRM: <http://users.ecs.soton.ac.uk/smaj08r/ontology/ALRM.owl#>
SELECT DISTINCT ?content WHERE {
?content DC:subject ?topic . FILTER regex( ?topic, "Semantic Web", "i")
?content ALRM: hasVersion ?learnCVersion.
?learnCVersion ALRM:hasLearningFeature ?learnFeatures .
?learnCVersion ALRM:hasPresentationFeature ?presentFeatures .
{ ?presentFeatures ALRM:hasModality ALRM:Audio . }
{ ?learnFeatures ALRM:hasSuitabilityLevel ALRM:Intermediate . }
{ ?learnFeatures DC:language “en” . } UNION
{ ?learnFeatures DC:language “fr”. }
{ ?learnFeatures DC:duration 30 . }
{ ?presentFeatures ALRM:hasFormat ALRM:AudioMp3 . }
```

Figure 4: SPARQL query

In the given scenario, Version-1 and Version-3 are not selected as they are of Video Modality, while Version 2 was of 50 minutes duration for Beginner level. Moreover, Version-4 was selected because the mobile phone was able to play an mp3 file and internet connection was good enough to play the audio of 128 kbps.

In Figure 4 - we present the SPARQL query we used to query the learning resource model based on the preferences we mentioned in the example scenario. Other presentation features like *FramesPerSecond*, *Bitrate* and *Resolution* can be included in the discovery query, but such parameters are not specified by mobile learner rather they are selected by the system for identifying constraints of the device and network connectivity condition.

5. CONCLUSION

In this paper, we discuss an important issue of discovery of Adaptive Learning Resources for mobile devices, which has not been previously addressed. We first highlight the importance of this issue and then propose a meta-model for adaptive learning resource. Our model enables the discovery of the right adaptive resource that has the potential most useful version for mobile learner to fulfil their needs, preferences and device capabilities. We have implemented the model using RDF and in the prototype application and used SPARQL for resource selection. We show usefulness of our model using a scenario and present an example model of learning resource based and a relevant SPARQL query. In future, we plan to build an adaptive resource discovery framework and build a mobile application to enable user to search adaptive resources for a right version by allowing user to specify his preferences and automatically retrieve device capabilities.

ACKNOWLEDGMENTS

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A Learning Design Studio in Mobile Learning

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ABSTRACT
Mobile learning is a young and vibrant field of research and practice. Teaching a university course on mobile learning is a challenge: how do you connect the theories and case studies to students' experience, and make them relevant for their educational practice? This paper reports on one such course which was conducted using a Learning Design Studio format: working in groups, students identified an educational challenge, conducted independent search and analysis of the relevant literature, devised an innovative solution and evaluated it. The studio approach has been used successfully by several researchers in the past. The course described here was conducted at the University of Haifa in spring 2012. During the course, students engaged with core literature, reviewed case studies, and designed, implemented and evaluated six mobile learning projects. We argue that the Learning Design Studio format is particularly suitable for teaching about mobile learning, as it situates students learning in a genuine context and allows them to learn through conducting meaningful research.

Author Keywords
Teacher training; Higher education; Learning Design Studio; Context; Practice; design-based research; learning design

INTRODUCTION

Designing a university course on mobile learning raises interesting questions: how should the course balance theoretical discussions with empirical results and case studies? How does it refer to, and challenge, media debates and common misconceptions about the use of mobile technology in schools? How does it bridge between the students' experience as naïve users of mobile technology and a desired stance of informed and critical educational innovators? What are the guiding principles which determine the objectives for the course, and how is the actual sequence of activities derived from these?

In spring 2012, such a course was offered at the University of Haifa, as part of the Technologies in Education M.A. programme. It was an elective course. Most of the students were experienced teachers or educational professionals. The course aims were defined as enabling students to critically examine the promises and risks of, and barriers to, the use of mobile technologies in education, through a review of the key literature in the field, analysis of case studies, and practical experience in the design of mobile learning activities.

This paper reports on the design of this course and its effects, through a joint account of the course designer and teacher and one of its students.

BACKGROUND

Diana Laurillard (2012) argues that teaching should be repositioned as a design science. If we accept this position, then university courses in teaching should adopt a model of design inquiry. Recent years have seen a growing acknowledgment of the value of training educators as learning designers (Voogt et al, 2011; Ronen Fuhrmann, Kali and Hoadley, 2008; Laurillard, 2008; Cross et al 2008). One approach which appears to hold significant promise in training learning designers is the learning design studio (Kali & Ronen-Fuhrmann, 2011; Hoadley & Cox, 2009; Cox, Harrison, & Hoadley, 2008). This approach is modelled after the tradition of studio-instruction in arts and design disciplines (such as architecture). In this model, the main activity of a course is the students' continued work on design challenges in a defined domain of practice. Students typically work in groups. They identify an educational challenge, research it, and devise innovative means of addressing it. The course instructor guides the students through the process, and classroom sessions are mostly dedicated to group work and public review of design artefacts.

THE COURSE STRUCTURE

The course was designed to bring students to adopt a design-inquiry approach to mobile learning. Design, in this context, is the informed creative practice of devising "*courses of action aimed at changing existing situations into desired ones*" (Simon, 1969, p 129). Inquiry-based learning attempts to shape educational experiences in the model of scientific investigation. Similarly, an inquiry approach to the training of educational practitioners should mimic the form of design research in education. Thus, the design of the course mimicked the structure of a design experiment (Mor & Winters, 2007), with the exception that students did not have the resources or the time to conduct several iterations, scaling up from a conceptual prototype to an extensive deployment. In a learning design studio, students work in groups on projects of their own choice. Each group identifies a concrete educational context and a specific educational challenge within this context, locates and reviews relevant literature, devise a techno-pedagogical innovation to address the chosen challenge in its context, and evaluate their innovation – if possible, by observing its implementation in the real-world context. The course ran for 13 weeks, and included 17 students in 6 project groups. Each group maintained a website for their project, instantiated from a template designed to scaffold their design process. The website template contained sections corresponding to the phases of a single iteration of a design experiment. Students replaced the instructions in the template with the content and artefacts they generated in the course of their work, so that when they completed the project, the website presented both its products and the process by which they were created. The course website (in Hebrew) is available as an open educational resource at http://courses.edtech.haifa.ac.il/mlearning and the student project sites are listed at http://courses.edtech.haifa.ac.il/mlearning/projects.

The first phase of the course focused on defining the context in which projects will be situated and the pedagogical challenge they attempt to address within this context. In the first week of the course, students were asked to propose an idea for a project they would like to develop. They then formed groups based on common interests, and spent the majority of the course time working on their joint project. Students documented and described the material, social and intentional factors which define the environment in which they will work, and expressed these in the form of a force map (Mor, 2011). Based on the tensions identified in the analysis of the context, students were asked to specify well-defined and measurable educational objectives. Next, they conducted preliminary research, reviewing appropriate learning theories and relevant case studies, and choosing the theories which they identify with and the cases which inspire them, as a basis for their design work.

Based on their articulation of the context and challenge, and the outcomes of their preliminary research, students developed an initial scenario, which included an outline of the proposed solution, and a storyboard depicting the learner's envisioned activities and expected learning trajectory. Students were instructed to consult the design principles database (Kali, 2006) or appropriate collections of design patterns (Mor and Winters, 2007). Students developed prototypes (or paper prototypes) of their solution and acted out the activities. After incorporating the lessons learnt from this experience, they proceeded to conduct a pilot study in the actual project settings, and evaluate the effectiveness of their design. In cases where conducting a pilot study was not possible, students conducted a heuristic evaluation of their design instead.

Finally, students edited their website to present their work - the design process, it's outputs, and their reflections. At this phase, students reviewed the record of their work and constructed a design narrative, recounting their experience and the lessons they learned. Students were also required to maintain a learning journal throughout the course, and comment on their peers work.

RESULTS

All 17 students completed the course successfully, and their feedback suggests they valued its contribution to their understanding of the core issues in mobile learning, as well as the pragmatic considerations of implementing mobile learning in realistic educational contexts.

Students expressed notable criticism about the course’s administrative aspects, as well as the workload which exceeded their expectations. Students also noted that the course would have benefited from an extended presentation, which would have allowed them more time to develop their projects and evaluate their implementation. Despite these shortcomings, students all acknowledged the effectiveness of the design studio approach, some noting that it has changed their attitude to the subject of mobile learning, and to technology enhanced education in general.

Six projects were completed, and are now available as open resources (in Hebrew) at: http://courses.edtech.haifa.ac.il/mlearning/projects

- UnVeil: a social game aimed at encouraging deeper social relationships and mutual familiarity.
- QRG: a location-based game using QR codes and virtual reality, aimed at enhancing social cohesion and connecting families to local history and geography.
- PQPA: A video Q&A platform, aimed at facilitating informal peer learning within a scholarly community.
- Biophone: a web and mobile platform to support inquiry learning in higher secondary school biology field projects (see details below).
- Museum Mobile learning: a mobile learning environment and activities designed to meet the educational agenda of the Hecht museum in Haifa.
- Math in the pocket: teacher training in using math4mobile to support maths education.

One student chose to continue his project as a final project for his degree. At least one team is still developing their project and collecting data. One student reported that the core features of his project were incorporated into a large scale initiative run by a national school network. These examples suggest that the course had impact which extended far beyond its presentation cycle – and affected participants' long-term professional practices.

EXEMPLAR PROJECT: BIOPHONE

A group of three students decided to design a mobile learning environment for biology at upper secondary school. As part of their matriculation exams, pupils[1] are required to conduct a biotope study. The project group included two experienced teachers, one of which was working at a secondary school and had access to biology teachers there.

As the first step of the design process, students were requested to define the learning context. To do this, they interviewed a biology teacher at one of the group member's school and constructed a model of the learning and teaching practices related to biotope studies; how do the pupils conduct their inquiries, in the field, at home and class? How much the teacher is involved her pupils' learning process and their field work?

The group analysed these practices to identify gaps and tensions which might impede the pupils' learning. Some of these concerned access to information during field work and a common environment for sharing the collected data. These issues were defined as the design challenge which the project will address. To inform their design, the group reviewed several case studies and possible technologies. For example: the 'Portable Information Technologies for Supporting Graphical Investigations' Project (Hennessy, 2000) in which secondary school students were given handheld computers to use in a collaborative project involving mathematics, science and geography skills; 'Epicollect' (Aanensen et all, 2009), which incorporated linking smartphones to web applications for epidemiology, ecology and community data collection and the 'ButterflyNet' project (Yeh et all, 2006) which included the development and evaluation of mobile capture and access system for field biology research.

Drawing on the analysis of the context and challenge, and the review of case studies and technologies, the group outlined a solution, which was designed to reinforce the connectivity between the classroom space, the pupils' field work and the teacher. The group proposed a combination of web and mobile technologies to address these needs.

The next phase was an intensive and iterative process of prototyping, role playing, experimenting, reviewing and refining the proposed solution. This resulted in a guiding website that combines mobile technologies. This website also provides a portable reference tool, with content, work instructions and tools for collecting data and field notes.

This site was presented to the teacher and her pupils for evaluation. The evaluation group consisted of nine biology pupils, aged 17, divided into three groups. The pupils were highly proficient mobile users, owning a variety of devices (iPad, Android phones and iPhones). They were enthusiastic about participating in the study, and particularly motivated to use their mobile phones in the course of their field studies.

Pupils use the website frequently in the course of their work. They report that the interface is user friendly and contains necessary details and can be used independently. In addition, using the links from the website for obtaining information was crucial for them in the field/in real time. The pupils enter observations data via on line forms and receive the data in an organized and clear fashion, for analysis and processing as part of their follow-up desk research.

The biology teacher is very satisfied with the use of the Biophone website to support the Biotope study. She acknowledges the contribution of the organized data and the collected information to the learning process. In addition she sees an advantage to the feedback she can offer as a result of the visibility of the data regularly processed.

Reflecting on the process as a whole, one student noted: "It took a long way to accomplish the goal. It wasn't easy to design such a learning space. It was big effort for us to transfer the general ideas we had in mind into real ones. We feel that we got useful and practical tools during the 'mobile learning' course for doing the design process. Our experience with collaborative project such as 'Biophone' helped us understand what mobile learning is."

CONCLUSIONS

Looking back at over a decade of research, mobile learning has established itself as a significant field of scientific inquiry. Yet projecting the outputs of research into practice is a challenge. Teacher training needs to address this gap, and there are several reasons for adopting a design-inquiry approach, where students learn through developing techno-pedagogical innovations in their domain of practice.

Specifically, the Learning Design Studio model appears to have the potential of achieving several aims, which are critical to the understanding and application of mobile learning:

- Acknowledging the importance of context, and developing tools for documenting and articulating context.
- Working out from a pedagogical challenge grounded in a concrete educational context, rather than in from a technological innovation in search of an application.
- Adapting rigorous habits of design inquiry modelled after the design experiment ideal – but adapted to the needs and constraints of educational practitioners.

[1] We use "students" to refer to the mobile learning course participants, and "pupils" to refer to the secondary school students.

- Combining personal construction and reflection with collaboration and communication as drivers of effective learning.

Educational practitioners often operate on the basis of their intuitions, and find it difficult to bind these to pedagogical theory. To counter this tendency, and allow them to retain their tacit pragmatic knowledge while adopting an attitude of scientific rigor, they need to acknowledge their role as techno – pedagogical designers. The suggested model may serve as a framework for those who aim to train educators as clear and conscious decision-makers. Carefully, with well-defined guidelines and supportive environment, teachers may become better learning designers.

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The Use of SMS Quiz System as an Alternative in Teaching and Learning

Azidah Abu Ziden and Muhammad Faizal Abdul Rahman

Abstract

This concept paper discusses the development of a system using SMS (short messaging system) to facilitate learning and also as a new method in the evaluation of teaching and learning. The design of a system that uses SMS for the quiz is proposed as an alternative for formative assessment of teaching and learning for courses at institutions of higher learning in Malaysia. The fundamental idea of the SMS assessment system is based on the SMS function which is the basic feature of the normal mobile phone to receive and send text messages at anytime and anywhere. This will allow the formative assessment to be done in a course with a more flexible approach. The fact that not every student can afford expensive mobile phone or smart phone which is the main obstacle in the integration of mobile phone use in teaching and learning in Malaysia of which this study aims to overcome. This gives room for the need to provide a simple system for lecturers and students using a normal mobile phone as a tool in the evaluation of teaching and learning. This article offers a new alternative for lecturers, teachers and students in the implementation of formative assessment quizzes via SMS.

Introduction

Various new technologies have been introduced to facilitate and improve the effectiveness of teaching and learning. Learning process which involves SMS (short messaging system) can be regarded as one of the latest innovation to support teaching and learning. Several researches have been conducted to explore the potential of teaching and learning involving the use of mobile devices (eg, Ally, 2009, Ford & Leinonen, 2009 & Gregson & Jordaan 2009). These researches were carried out in various areas. The use of mobile technology in the education sector in developed countries is increasing and the study using mobile devices in teaching and learning have also shown an increase in Malaysia. A number of researchers have tried to use the SMS function to communicate in their courses such as sending a note and sending information or notification (e.g. Tina, Mansor & Norziati, 2011). However, there are fewer researches that focus on the method of two-way communication between lecturers and students and as well as assessment system based on SMS. Currently, most research only focuses on one-way interaction between lecturers and students for example a lecturer send a note via SMS to their students by Munirah et. al (2009). Many researches are still at an early stage where SMS is sent only from the lecturer to students, not vice versa. Although the SMS technology is the same technology that can be obtained through the use of mobile devices, to develop evaluation systems that use SMS is quite complicated because it includes the character limit, consumer credit, special instructions and common problems in mobile system such as mobile coverage and SMS providers bulk limit (delayed response).

This article proposes a new method that uses SMS mobile technology to optimize the use of mobile technology and the Internet. Although e-learning is seen as a platform ready to be used in any field of education, it cannot be fully utilised in certain countries such as Malaysia because of the limited Internet coverage. Therefore, learning using mobile devices through mobile phones is considered as a potential new method of teaching and learning. According to the Malaysian Communications and Multimedia Commission (2009), the statistics report on Phone Subscribers in Malaysia, stated that;

> "The penetration rate for mobile phones is expected to exceed 100.0% in the first quarter of 2009. Penetration rate refers to the number of subscriptions divided by the

total population and multiplied by 100. More than 100% penetration rate may occur because of the use of more than one device by a user."

The report shows that mobile phone subscriptions in Malaysia increased in early 2010 and is expected to increase from time to time.
The use of mobile phones among students in universities and colleges has become a necessity. Briggs (2006) suggested that a text message, also known as short message service or SMS has changed the landscape of communication in the university campuses. Norbayah & Norazah Mohd Suki (2007), in their study, suggested that 98 percent of the respondents in their study aged between 17 to 30 years old have their own cell phone while the remaining have a PDA / pocket PC / palmtop or smart phone in Malaysia. In the study by Munirah Rosli et al (2010), it was found that the use of SMS as a medium of communication in teaching and learning for distance education courses at a university in Malaysia is useful to support the learning needs of the students. However, the biggest constraint found in their study is the difficulty for students to access the course content through mobile phones. This is because the system offered only caters for one-way communication method and does not provide students the access to the contents published by them after the information is sent via SMS.

In this study, the researchers plan to explore the use of SMS in the evaluation of teaching and learning using the quiz via SMS. A quiz via SMS system will be designed to implement the evaluation which can be conducted anywhere without the limitation of time and place. The construction of the quiz via SMS is expected to be able to offer~~:~~

- Access at any time, any place for a quiz-based assessment of various courses.
- Flexibility in terms of time for the assessment on quiz based teaching and learning, and
- Support learning and continuous assessment by experts to students

Mobile Learning and Electronic Learning
This article will explore the methods of teaching, learning and assessment of learning which attempt to highlight the concept of portable (mobile) learning compared to the electronic learning environment (e-learning) to achieve educational objectives. Laouris & Eteokleous (2005) suggested that e-learning is a platform to be strengthened by the following elements namely multimedia, interactive, links, and media diversity. However, there are lecturers who are reluctant to offer online learning for various reasons such as reduction in human interaction, failure of technology, the efficiency of technology to change students and the increased workload in the faculty (Beard & Harper 2002). William & Black (1998) suggested that the measure of students' ability to answer each questions is not only based on their understanding of only the topics studied, but it is also based on their response to a variety of other features such as language, the context of the questions, or the pupils level tiredness at that time. Moura and Carvalho () suggested that mobile learning …………..
Therefore, this study attempts to offer the use of teaching and learning methods involving the use of mobile phone platform to enable the delivery of the course assessment in a more flexible way according to the needs of the students. However, Attewell (2004) cautioned that it is important to realise that mobile phone is an individual’s 'personal space' and the use of that space as a means of teaching and learning may be considered as invading the personal space.

Quiz as a Method of Assessment in Teaching and Learning

There are various methods of evaluation of teaching and learning either through formal or informal methods. Quizzes can be viewed as one of the formative evaluation method in which it is usually done in stages or continuous manner for the assessment of a particular topic or subject. This is not something new despite the various terms used to describe formative evaluation. The difference between formative assessment methods are the way it is conducted and the approaches it used. Quiz as a method of formative assessment has been through various methods of implementation from pen and paper method to the online quiz. Feedback from formative assessments allows students to better understand the expectations of teachers, and it also allows teachers to modify the course work to address better the needs of students (Rolfe & McPherson, 1995). Peat & Franklin (2002) in their study stated that their students think that the best aspect of the quiz assessment is when they get immediate feedback, the quiz is in (options/choice/selection) format and quiz can be completed quickly. Normally, evaluation done through quiz approach is by giving a certain percentage for students to increase their motivation to do the quiz. The study of Kibble (2007) found that by offering (credits/marks) for online quizzes, it will increase the participation among students. Kibble (2010) found that students' participation in the quiz which was held as one of the formative evaluations will assist them in achieving consistency in the subjects taken.

Research Objectives

The objective of this study is to design and develop an integrated platform that enables the implementation of student quiz. The system aims to:

- Optimize the collaboration and assessment methods for university courses that utilise this system.
- Implement, analyze and evaluate the quiz application via SMS and web portal.
- Identify usability and openness of users in using the SMS system in the evaluation of learning and assessment.

Research Methods

This study will be conducted gradually. The research phase is elaborated as follows:

Curriculum Requirements and Analysis

Curriculum requirements and analysis was carried out to determine the scope and content of the SMS system used for this study. This section will identify the appropriate courses to test the applications developed for the SMS quiz system in order to determine the development of the design of the SMS system. The information about the content is needed to carry out the analysis of the needs of current strategy and innovation for teaching so that new design achieves the maximum learning and teaching effect. The design stage which includes the involvement of researchers and experts in mobile device helps to develop the best system for the purpose of research.

The course chosen will determine the respondents of the survey. Quantitative and qualitative methods for data analysis are conducted to address the objectives and hypotheses of this study. It is also to enable the researchers in identifying the strengths and weaknesses of the design of the first phase of the SMS system for the study. In an effort to identify an SMS users' level of openness in embracing the students' learning and assessment system, the quantitative data and qualitative data collected from the lecturers will be used to identify the usability of SMS applications in the quiz.

SMS Design System for the Quiz

Quiz in the form of "objective questions" is proposed as it is deemed as more suitable to support the first phase of this research. The main reason for this because the "objective questions" (multiple choice questions) are easier than quizzes in the form of essay questions. It is also suggested that the question and answer type of evaluation is used and explored in the design phase of the study. The application of the question answer design is the early part of the application of research forum where students can discuss their views with ~~the~~ other groups and this occurs through the medium of SMS discussion.

The concept of this study is learning activities through text and mobile web portal (to store / organize activities).

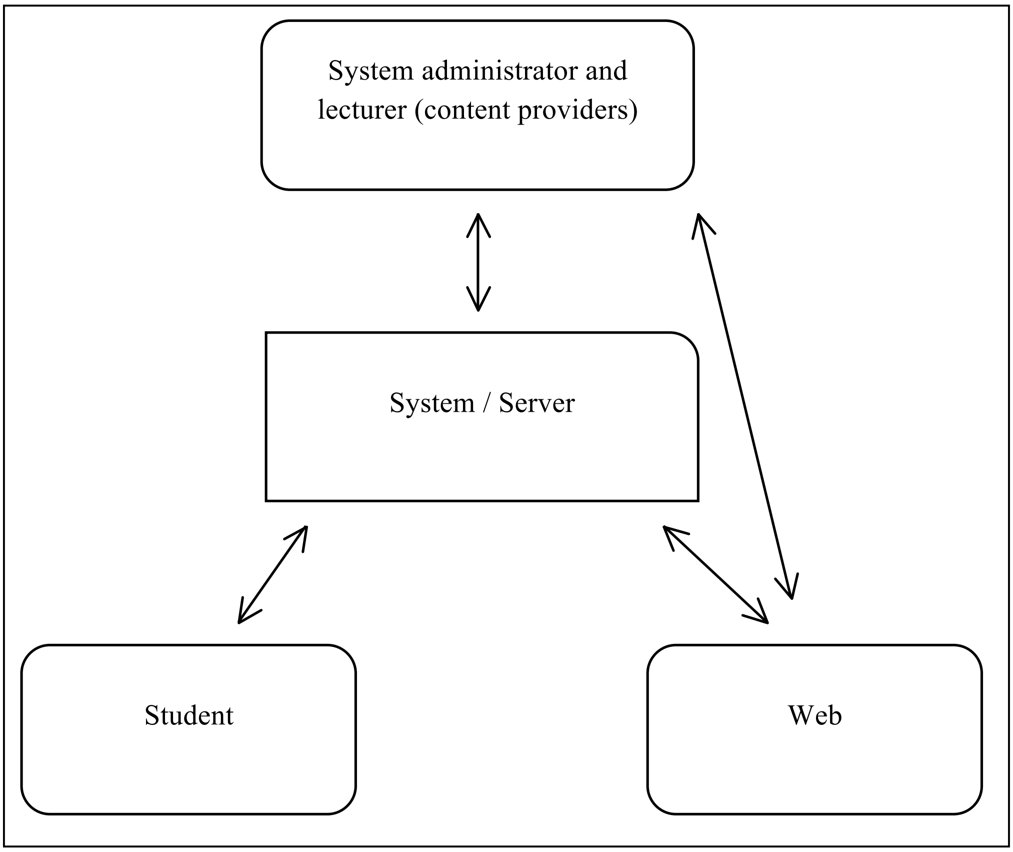

Figure 1: System quiz via SMS

In Figure 1 (above), the flow of activities is as follows:

1. Administrator of the SMS system / lecturer will send the SMS quiz in the form of questions to be answered by the students through the server / SMS system.
2. Server / SMS system will send SMS to the students and the web portal.
   a. Students will receive a quiz / questions in their mobile phone
   b. The website will automatically store and organize quizzes / questions in the web portal.

When students receive questions and then answer the questions, the information will be sent to the server / SMS system. The server system, SMS / mobile will process responses and displays them on a website and store it in the portal. Lecturers will be able to access the website to enable them to look at the entire quiz (questions and answers).

In the design of this study, it is suggested that the time limit is given for students to answer the questions. If the student answers the questions beyond the time limit given, it is proposed that:

- SMS notification is sent to notify that they will no longer be allowed to submit any answer because the time limit has expired.
- OR the website portal indicates that the SMS is sent and the lecturers will be able to know the time of the answer was sent then consider whether to accept the answers of the students who submit late or otherwise.

The database for the SMS server system will also process the message in the system and identify whether it is a multiple choice quiz or a module of questions and answers. Quiz application will be designed according to the lecturers' needs, while the question and answer forum will be more flexible in terms of interaction between lecturers and students.

The development of the quiz via SMS

The SMS quiz system is being developed by the researchers through certain stages. The main tool used in the development of this system is a server that operates on *Microsoft Windows Server 2008* and SMS modem that is supported by 4 SIM slot. Each development process will go through the process of testing and system stability to ensure that the system will work properly during the actual research. The development of the system via SMS quiz used the ASP & PHP programme in which the quiz will be uploaded to the system using the Microsoft Access and Microsoft Excel programmes. Lecturers are asked to provide a 'bank' of questions in which the data from the 'bank' of question is then programmed to be drawn randomly by the system. Students will receive quiz questions which is randomly selected from the system to ensure reliability in conducting the quiz at anytime and anywhere outside the classroom.

The figure below shows the quiz delivery process to students via the SMS quiz system developed by the researchers.

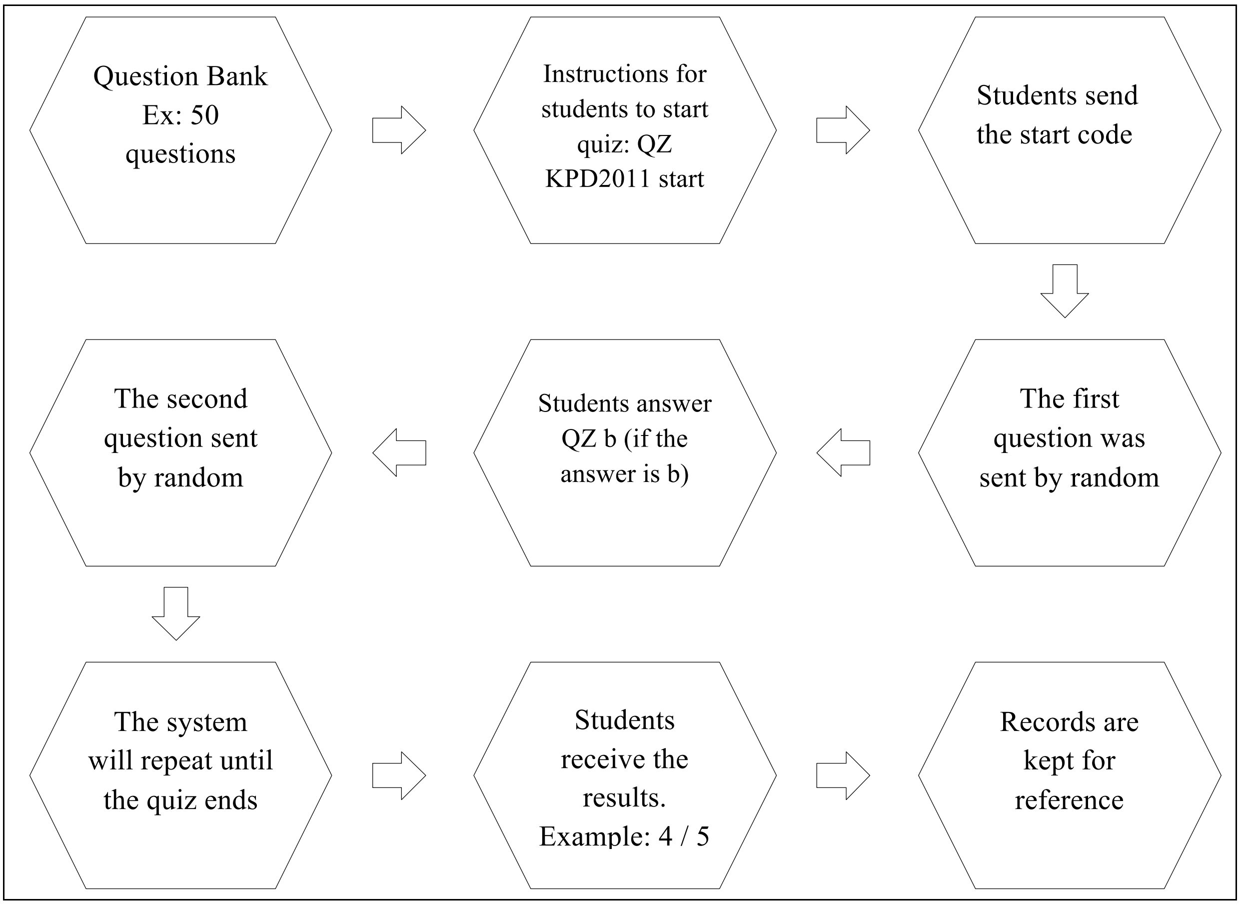

Figure 2: Flow chart of the SMS application process

In developing the quiz system via SMS, user information such as name, phone number and e-mail address is registered into the system either through the manual registration (performed by the System Manager) or automatic registration which can be done by the user on the website provided. After all the user's information has been entered into the system, the users will register on their own for a specific subject using a unique course code, for example KPD3333, for the course taken. The quiz configuration process will be conducted by the System Manager or the lecturer to determine the date and time the quiz will be conducted for the course.

The early Stage of System Testing

In the initial test of this quiz system via SMS, researchers found that there are some constraints and issues in the operation of this system that needs to be addressed before the system can be utilized optimally. These constraints and issues are divided into three levels of issues involving the system, the issues involving the users / students and general issues. The issues in the technical matters of the system to be considered during the development of this quiz system via SMS are the issue of an unstable modem, the modem does not work (hang) and others.

The main issue in the early system development involves users who are students as they are the main users of this quiz system via SMS. In the early stage of testing this quiz system via SMS, tests were conducted on 100 students to examine the stability and usability of this system in general. When the system sent the wrong command to start the quiz, it was found that it was difficult for the students to understand the instructions to start the quiz. For example, when the students were asked to start the quiz by sending a simple SMS command: *To start the quiz, please send "QZ KPD3333 START" to 0122345678.* The students were confused over technical matters such as where to put the space between the codes, the need to use small or capital letters and send thank you after receiving instructions. Such issues have made it difficult for the students to do the quiz. Confusion also caused students to answer the quiz questions not according to the prescribed instructions. There are also student who answered the quiz question twice, most likely to correct the previous answer.

Recommendations to ensure smooth delivery of the system via SMS quiz.

To ensure an efficient system for process-based assessment quiz via SMS, the system and database must be monitored to ensure that students can answer the entire quiz. A problematic system might lead to students becoming bored and not motivated to continue the quiz until the end. The results from the pilot studies have also found that there are students who tried the quiz for a few times because they felt very excited with the ability of the system to supply the quiz questions and answers instantly via SMS. Online help is important to get feedback and to help students if there are any problems during the quiz. To get cheap and affordable costs for the students, it is recommended that the service providers (telcos) used is the same as the students' mobile phone service providers. A balanced distribution of the service provider will also ensure a smooth delivery of the SMS system.

Through the initial test of the SMS quiz system which is still being developed by the researchers, it was found that the system is appropriate and can be used efficiently by 100 students in four hours. At the initial test, a quiz containing five questions was properly carried out by the SMS quiz system developed by the researchers. However, it is recommended that the system has a backup system to ensure the smooth running of the quiz if the main system breaks down.

Conclusion

Although the process of design and development of system evaluation quiz via SMS is still in its early stage, it is predicted that this system will be able to attract the attention of lecturers and students in the Higher Learning Institutions to engage in a more flexible teaching and learning process. In general, it is expected that this study could provide substantial benefits to lecturers and students, particularly in maximizing the use of mobile phones in teaching and learning. Furthermore, this study will help lecturers in improving the quality of education in two ways; 1) to improve and increase access to education and educational assessment anywhere and at any time 2) to promote new methods of teaching, learning and assessment process that can be accessed by students without relying on computers and the Internet. The concept of this quiz via SMS is seen as a method of evaluation that meets the demands of teaching and learning without borders. By using the SMS feature available in the mobile phone, the system is expected to help lecturers in the evaluation system that can be done outside of class time in a simple and quick manner.

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Mobility and multi-modality – An exploratory study of tablet use in interaction design learning

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ABSTRACT

Tablet computers contain affordances that could make them particularly useful for students in interaction design. However, there is a lack of research and guidelines on how to integrate mobile tablets in learning. In this paper, we aim to gain understanding on the use of tablets in interaction design education by conducting a case study in an undergraduate class in interaction design. We frame our results in five features of mobile devices. Mobility and multi-modality stood out as the most distinct features of tablets in interaction design education.

Author Keywords

Affordances, Interaction Design, Mobile Learning, iPad

INTRODUCTION

Mobile devices support students in formal as well as informal learning activities (see e.g. Klopfer, Squire, & Jenkins , 2002), but may also disrupt learning (see e.g. Taylor, Sharples, O'Malley, Vavoula, & Waycott, 2006). The question for educators is how to handle these formal, informal and disruptive aspects when designing for learning. Our main goal is to seize possible opportunities for tablets in learning activities in higher education, especially in interaction design education. We approach this goal in an iterative design manner. This paper reports the findings from the first iteration of a learning design.

We studied the use of tablets in a class of interaction design students by means of direct observation, interviews and diaries, and elaborate on Klopfer et al's (2002) five features of mobile learning. These features can be used as lenses for us to understand how students use mobile tablets in their daily learning activities.

Klopfer et al. (2002) suggest five features of mobile devices, in the context of learning and augmented reality: Portability, Social interactivity, Context sensitivity, Connectivity and Individuality. These affordances make the mobile devices especially valuable in many different educational contexts (Naismith, Lonsdale, Vavoula, & Sharples, 2004), but learning interaction design is a context that is different from e.g. inquiry-based learning. It is also about learning facts about the world, but less formal and with the added factor of changing that world in some constructive manner.

Design aspects are not the focus in this paper. Instead, we are more interested in finding out affordances of tablets in a learning context, in order to provide a platform from which to discuss how to design learning activities. For interaction design students, learning activities with tablets may potentially involve collaboration, visual presentation, multimodal interaction, etc., as well as the ability to capture the design inspirations anytime, anywhere.

CASE STUDY

Overview

We introduced iPads to the undergraduate students enrolled in an interaction design program and provided each student with an iPad, a stylus pen and a set of apps installed on the iPad. The apps were roughly categorized into two groups; 6 productivity apps, (e.g. Pages[1] and Keynote[2]), and 6 design apps, (e.g. Sketchbook Pro[3] and OmniGraffle[4]). Together these were intended to be useful in their learning activities: taking notes during lecture, brainstorming in group meetings,

[1] http://www.apple.com/apps/pages/

[2] http://www.apple.com/apps/keynote/

[3] http://usa.autodesk.com/adsk/servlet/pc/index?id=6848332&siteID=123112

[4] http://www.omnigroup.com/products/omnigraffle-ipad/

sketching ideas, creating graphic design, writing reports and giving presentations. 9 students (3 female and 6 male students with age between 21 to 34) participated in our study on voluntary basis during a course in "Graphic Communication" starting in January 2012 and running for 4 weeks.

The students were given a lecture and a graphic design assignment every Monday. They were required to present their initial design concept on Wednesday during a supervision lecture, and then submit their final weekly task by Friday. The assignments were all done in groups and each group has 4 students. The students were not required to use iPad in their course assignments. By allowing them to use iPads freely, we hoped to understand which possibilities students would see and what problems they would encounter.

Method

We conducted the study during two weekly tasks, in week 1 and week 3 respectively.

During week 1, we concentrated on iPad usage during students' group work session, while the study in week 3 concerned individual iPad use. The data from week 1 included notes obtained from a 1.5-hour participatory observation of one student group meeting, snap shots of their work in process and notes from semi-structured interviews with the 4 students in the group.

During week 3, all 17 participants were required to keep a diary for 5 weekdays recording their daily usage of iPad and its relation with their learning process. We wanted to investigate how the students used iPad on a daily basis, without disturbing them, and also allow them to work in various places and times. A diary method (see Bolger, Davis, & Rafaeli, 2003) was deemed appropriate for this kind of study. The diary was created as a fillable PDF file and returned to us via email every evening. The diary contained questions such as *how long, where* and *for what* the iPad had been used, and *which applications* were used. There were also text fields for positive and negative experiences.

FINDINGS

Learning anytime anywhere

The participants used the iPad in school, on public transportation, cafés and restaurants. Several participants reported the informal aspect learning outside of class.

> *"It is easier to pick up an iPad and start working than a computer. And more comfortable to read on."*
>
> *"(iPad is) more relaxing, less 'tool-like' than a computer."*
>
> *"(iPad is) quick to prepare and use, smooth and easy."*

Figures 1 and 2 show how a group of students used iPad in their weekly project. The assignment was to find something in the city that was not well designed, and then propose a new design concept to make a change. One student felt a subway station was dark, cold and emotionless. So she took a picture of the hallway in the subway station in order to suggest a redesign.

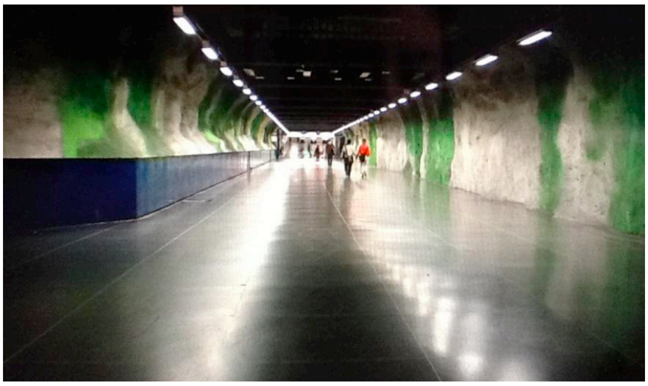

Figure 1: Photograph taken by a student in the subway station

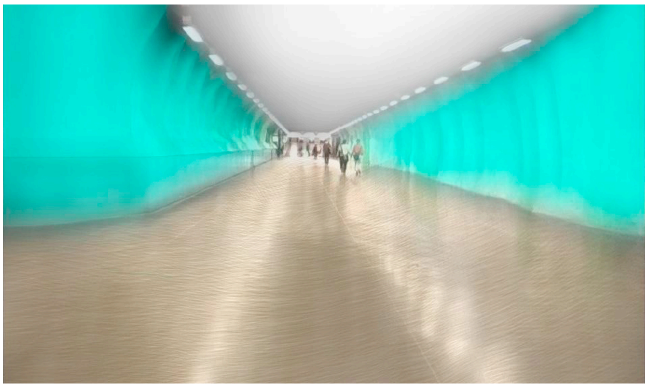

Figure 2: The sketch students created based on the photo

The student group decided to work further on the idea of changing the interaction between the passengers and the physical environment in the subway station. Figure 2 is the concept sketch the group created during their group meeting.

Two students were concerned about theft and were unwilling to bring iPads to public places and longer trips. This suggests a gap between the administration guidelines (students responsible for hardware) and the course design (hardware to be used everywhere): *Mobility* can be either supported or limited by the design of the learning activities, the requirements of the courses and the regulations of the educational institute.

Staying connected

Daily activities included reading news, sending emails, communicating with friends via instant messages and checking updates in social networks. Students shared learning materials via emails and apps like Dropbox[5], and Evernote[6]. They also shared the information among the different devices they had, such as computer, mobile phone and online storage.

> *"I like Evernote. Awesome app that I can run on the computer, phone and iPad."*

The participants also accessed course materials, posted questions to the teachers and discussed assignments with other students anytime, anywhere.

None of the students used a SIM card for their iPads and some tried workarounds such as connecting iPads through their mobile phones:

> *"I use my iPhone as Internet hotspot and it annoys me that when you put iPad to sleep and then start it again, the Internet get lost and you must restart Internet sharing on your phone Internet connection"*

Their *connectivity* was otherwise limited to certain physical locations, where wireless networks were available, such as university buildings and students' homes.

Customized Learning

Mobile tablets are designed for individual use. Different students had very different interests and ways of learning. The followings are quotes from some of the participants describing how they used iPads.

> *"I have mainly used the iPad to read textbooks…I have also tried to use it as a tool for writing CSS / JavaScript, but find it quite difficult. I have made a few mockups of websites, but not quite got into a good workflow."*

> *"I have used iPad to make music instrument. And for musicians, it is fantastic."*

> *"I have used iPad for doing graphic design, reading news and taking notes."*

Some of the participants' comments also indicated the students carried iPad with them and supported their learning in different ways.

> *"iPad is like a scrapbook, in which you can collect inspirational materials that you can take with you everywhere."*

> *"(iPad) is great for taking notes. Forgot my pen and paper today."*

However, as Sharples (2002), Sharples et al. (2005), and Taylor et al. (2006) have previously discussed, iPads were also used disruptively, e.g. for playing games during lectures. Still, doing the course assignments was the most frequent activity the students use iPad for, and graphic design apps had the highest frequency of usage. Courses and learning activities design of mobile learning need to find a balance between the *individual's* level of customization and organizational control of usage.

Collaborative learning

Collaborating was the second most frequent activity the participants use iPad for. Normally, students had to book a group meeting room with limited hours. When such meetings rooms were not available, they had to carry their laptops around and find a common space. But the laptops were bulky, and had limited battery capacity. The tablets supported more flexible student collaboration during their group design assignments, especially in the early design stage.

However, mobile devices are mostly designed for personal use. This posed a limit collaborative learning activities. For example, we found that the collaboration among the students was often controlled and directed by the student who was using the iPad. This was very different from how they would interact with each other on a shared computer or in front a whiteboard. If the workload is not equally distributed among the students, some students may learn less than they would otherwise.

Multimodal Interaction

With the help of various apps that support sketching, brainstorming and prototyping, iPads helped the students work on their assignments during the ideation stage of the visual design and enhanced the students' learning experiences.

> *"I like it as a portable sketchpad, great to have to write down or draw your ideas."*

---

[5] https://www.dropbox.com/

[6] http://evernote.com/

I did use it for showing some ideas that we had drawn out on Monday for a poster idea to the class when the computer failed to render proper colors.

Unlike pen and paper, tablets enabled the students to try out different colors, go back and forth to check ideas, restore all the sketches and share them with group members.

The tablets allowed *multimodal interaction* for input and output, including visual, audial and kinetic interactions.

FEATURES OF MOBILE TABLETS IN EDUCATION

Based on the findings, we appropriated five features (Klopfer et al., 2002) of mobile devices. These features suggest what affordances were at play, and may act as a frame for educators to examine and/or design interaction design learning activities.

- Portability/Mobility – Learning activities took place semi-informally, and out of the school context. This is one of the two aspects we found the most interesting, because students worked with their projects in novel ways that were not possible with traditional devices. Proper task design was a key aspect here – a balance between an interesting task and freedom to interpret that task and make use of technology (See figures 1 and 2).
- Connectivity – Students managed to fulfill tasks without being connected at all times. Being disconnected was perceived as an annoyance for them, albeit a surprisingly small one. Nevertheless, educational institutes may wish to consider how to handle the economical aspects of student connectivity.
- Individuality – Because of the informality of the learning tasks, students used their tablets in diverse ways. More structured tasks would steer students towards less individual ways of conduct. Again, there is a balance between structure and freedom.
- Collaboration – Tablets worked well for co-located activities, probably because of the possibility to lay the tablets flat down before everybody to see. However, there were also problems with one person controlling the tablet and the others watching.
- Multimodal Interaction –While tablets are context sensitive (e.g. location services), we found that the ways of interacting with the environment was more important than automatically gathering context data. In figures 1 and 2, data was collected by the student's initiative rather than automatically by the device. We propose that the term "multimodal interaction" captures both these ways of interacting with the surroundings better than "context sensitivity".

CONCLUSION AND FUTURE RESEARCH

This project is an on-going study. One contribution of our work at the current stage is advancing Klopfer et al's (2002) five educational features of mobile devices in the interaction design-learning context. These features can act as lenses for educators to understand the use of the mobile tablets in the students' learning activities. Mobility and multi-modality stands out in particular. Mobility allowed novel kinds of semi-formal tasks, and our students made use of multi-modality rather than context sensitivity.

The next steps of the project is 1) to develop these features more into the concept of educational affordances and 2) to evaluate students' learning activities in other kinds of courses.

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Towards Mobile Curriculum with Systemic Learning Solutions

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ABSTRACT

In this article, we discuss a work-in-progress study project, in which one of the main goals is to bring out the most relevant qualities of technologies for the instruction and school development. The Systemic Learning Solutions (SysTech) project is a joint value network project in which learning solutions are co-designed and created among research institutes, 12 companies and a wide range of educational piloting environments. The aim is 1) to find new and innovative approaches in curricular design including current and emerging mobile technologies, 2) to explore mobile learning in and across formal and informal settings, and 3) to create adaptive, virtual or collaborative environments for mobile learning. This paper presents some background knowledge, six key characteristics (Zhang et al., in press) of the mobilized curriculum (Looi et al., 2011.), a testing model, and initial findings from the first pilot experiments.

Author Keywords

Mobile learning, learning solutions, curriculum design, innovative learning

INTRODUCTION

The SysTech project aims to promote the learning and teaching of 21st century skills Binkley et al. (2012) and Finnish educational know-how by validating, implementing and disseminating innovative learning solutions on a large scale into different educational systems. It is a joint effort of two universities, 12 companies and a wide range of educational piloting environments. The project will build a portal of systemic learning solutions, consisting of six product families.

Mobile devices, one of the product families, bring new opportunities for teaching and learning, e.g. by creating authentic learning experiences to solve real life problems. They are cheap, portable, have no start-up time, require very little maintenance, and are easy to use. Students can exchange data quickly and accurately with peers without cluttering the classroom with cables, and can move among various collaborators in the classroom and establish a face-to-face interaction. For pedagogically effective and meaningful use of mobile technology systematic research and practical support and development are required.

The aim of the research experiments performed by SysTech is to explore what the user experiences are, how the mobile learning solutions could be improved and to define what the added value from using the learning solution is. In addition, we examine what kind of pedagogical support will be needed in the implementation process of mobile learning solutions. In this paper, the aim is to describe how we have been to building curriculum driven use scenarios based on theoretical framework of mobilized curriculum.

MOBILIZED CURRICULUM

We establish a theoretical framework based on earlier research on the pedagogy of mobile learning and learner-centered knowledge creation methods in network-based environments (e.g. Roschelle & Pea, 2002; Kynäslahti & Seppälä, 2003; Tella, 2003; Chan et al. 2006; Vesterinen et al., 2006; Sharples et al. 2007; Roschelle et al., 2007; Squire & Klopfer, 2007; Vahtivuori-Hänninen, Karaharju-Suvanto & Suomalainen, 2008; Spikol et al., 2009; Shear et al., 2010; Vavoula et al., 2009; Tuomi & Multisilta, 2011; Mylläri et al., 2011; Nousiainen, Kankaanranta & Neittaanmäki, 2012). To promote school development based on the new affordances and activities introduced by mobile learning solutions, we expand the earlier research with the concept of a mobilized curriculum (Looi et al., 2011, 272). Zhang et al. have listed the key characteristics of mobilized curriculum as follows:

- Mobile technologies are exploited to achieve learning in context
- Studying consists of student-centered and inquiry-based learning activities
- Constant access to student artifacts is utilized for formative learning assessment and adjusting teaching/instruction
- Collaborative interactions are enabled and promoted
- Community support and resources are enabled and utilized
- Teacher development for curriculum development is facilitated

Our research objectives bring together ideas from three following strands:

- New approaches in curricular design
- Contextual learning in and across formal and informal settings enabled by one-to-one computing.
- Mobile technology as a learning hub

As a novel approach to curricular design, the mobilization of the existing curriculum and conventions of instruction can take form in a single, mobilized lesson (Norris and Soloway, 2008) where e.g. an initial paper-based design is reshaped into benefitting from use of mobile technologies. On the overall level, a mobilized curriculum captures the systematic transformation from a content- and teacher-centered to a student-centered infrastructure, that fosters personalized and self-directed learning (Looi et al., 2009).

One-to-one computing in education means that learners have access to personal mobile devices at all times to mediate both the classroom and out-of-classroom learning activities (Looi et. al., 2011). The corresponding concepts such as "seamless learning environment" are used to bridge formal and informal learning (Chan et al., 2006). One-to-one computing encourages the design of mobilized lessons or learning projects to include elements such as interaction, collaboration and peer-teaching.

The mobile technology can be seen as a 'hub', that activates and integrates the variety of students' learning resources, e.g. digital repositories, personal learning spaces and channels for peer communication and information. It also enables the digital production of artifacts that reflect conceptual understanding; as well as provides support for sharing, commenting and revising knowledge representations. These learning premises are strongly felt to emphasize students' ability to take responsibility as well as ownership for their 'personal inquiry' (e.g. Looi et al., 2011).

RESEARCH QUESTIONS, METHODS AND DESIGN

The SysTech research questions address areas such as strengths, weaknesses and applicability of the learning solution to the curriculum-driven teaching-learning process quality and style of learning. Concerning the mobile technology, our research focuses on the transformative process of redesigning existing curriculum and the corresponding learning activities.

Data have been collected with online questionnaires and participant observation. In the pilot experiments, all learning solutions go through what we have labeled as the SysTech Testing Model:

- Assessment and analysis of the learning solution and the piloting environment performed by the researchers and experts in the field in order to address questions such as technical and pedagogical usability.
- Co-design of the pilot experiment. This is a collaborative effort of the researchers and the actors of the pilot environment.
- Pilot experiment with users of the pilot environment testing the solution as part of their current teaching-learning activities. The main data gathering method during the third step is observation.
- Data analysis
- Agreeing on the iterations and their modifications performed within the same pilot environment beginning again from the second step.

BUILDING USE SCENARIOS

Citynomadi, one of the mobile learning solutions, has been studied in two pilot cases. Citynomadi is a combination of services consisting of a mobile application for automated tracking and storing of user location, route and e.g. photos, videos and QR-codes. The objective of Citynomadi pilot experiments was e.g. paying special attention to teaching and learning 21st century skills, e.g. creativity, critical thinking and collaboration (see "KSAVE-model" in Binkley et al. 2012). The first pedagogical use scenario addressing 10 lessons was intended for a 5th grade local history projec, where students used the mobile application installed onto their own smartphones to follow the routes created by the teacher and to track routes for the other students to follow and perform tasks on.

Looking at the initial findings, the option to work on the subject of history not only while moving independently outside the classroom, but also while utilizing personal mobile devices often restricted or banned from school work altogether was considered as a very positive factor. E.g. preferring Citynomadi over working with the history book was obvious (e.g. 66% of students agree or strongly agree with the proposition “learning history with Citynomadi is more stimulating than with books”). However, the students were not sure of how much the activity promoted the actual learning of history. From teacher’s perspective the experiment with the learning solution seemed to be very rewarding. It e.g. provided new ideas on how to apply the technology in other subjects and on how to restructure the pedagogical-technical support available for implementing projects like this during the next semester.

The second use scenario was conducted within an interchange programme between two international schools of Helsinki and Barcelona, in which Citynomadi application was used in creating, sharing and exploring city routes together with the primary school children and their teachers. Descriptions, activities and pictures of drawings and scale models created by children as well as videos and links related to different places of interest were inserted into the city route maps. Through sharing the maps publicly in the Internet, children could express their points of view about their hometown.

From the perspective of 21st century skills, the pilot’s intercultural nature enabled practising intercultural communication a well as collaboration and skills needed for global citizens. Learners were able to express creativity and innovativity when designing and creating contents for the maps. Children also practiced using virtual maps as well as technological skills and skills needed for acquiring good information literacy skills. Teachers viewed the activity positively but one of the biggest challenges is that designing cross-curricular and cross-cultural activities similar to this requires lots of time and collaboration between different teachers, which is not easy to arrange in hectic school environments with different timetables. Teachers should be given more time and support so as to be able to include similar projects in their regular lesson plans and to integrate them in the official curriculum.

CONCLUSIONS

In this paper we have presented our on-going efforts on constructing a theoretical framework for mobilizing an existing curriculum. We have also demonstrated mobile learning use scenarios designed together with teachers and students in the educational pilot environments. This paper is based on work-on-progress study and thus presents preliminary insight and results on these themes. With the theoretical framework we aim at building new approaches for curricular design and embedded innovative teaching practices. In Finland schools have a lots of freedom to develop their own local curriculum. The national core curriculum gives only a framework (see e.g. Niemi et al., 2012; National Core Curriculum, 2004). This allows schools to apply ICT and mobile tools in their own individual kinds of practices.

The pilot experiments have indicated that the co-construction of the use and implementation of mobile learning solutions together with teachers and pedagogical ICT experts enables their better integration into the curricular needs of different learning environments. This kind of mobilized curriculum and classroom learning activities requires one-to-one computing. However, the current state of restricted ICT access at schools challenges the possibilities of large-scale take-into-use of mobile use scenarios. In our study, we aim at carefully analyzing the factors related to effective technological and pedagogical take-into-use of mobile solutions. Our special focus is on the design of versatile pedagogical models and support structures as earlier research has pointed the slowness of change processes at school cultures compared to the speed of technology development, also in regard of access issues. In our framework of mobilized curriculum we conceptualize mobile technology as a learning hub for the mobilized curriculum. This emphasizes self-directed and collaborative learning as an integral part of a school’s learning activities.

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Pedagogy, continuance theory and mobile devices: Findings from a New Zealand case study

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ABSTRACT
In 2010, a short-term case study project undertaken in an urban secondary school investigated various mLearning options in a range of classrooms. Mobile devices included students' own cellphones and/or digital cameras, as well as some proprietary software and hardware. Four different classrooms, teachers, subjects and classes participated in the research evaluation, which reported on effects these digital technologies had on pedagogical practices and school infrastructure. The case study used interviews, observation and the collection of artefacts (video, still shots) to provide qualitative data for thematic analysis. The teachers and IT support were all mature professionals whose pedagogical knowledge and practices were already secure. This paper focuses primarily on discussing the pedagogical practices of the teachers and some implications of viewing their experiences through the lens of continuance theory and socio-cultural perspectives.

Author Keywords
Mobile devices, mLearning, pedagogy, secondary schools, case study, continuance theory, socio-cultural ecology theory.

INTRODUCTION
This study grew from one teacher's trials with using mobile devices (such as cellphones, mp3 players, iPod Touches) as data storage and playback facilities. This was at the teacher's former school, where students, mainly from a low socio-economic urban area did not have computers at home, but had cellphones. The trials were initiated by students wanting to know if they could use their phones, instead of having to use computers, to store and retrieve digital files. This led the geography teacher with support from an information communication technologies professional development (ICTPD) facilitator and his students, to finding out. When the teacher moved schools, he built on the national and international awards gained for this work in 2008 (Wilson, 2011). Together they discovered a way to create digital content files that could be stored and read on cellphones, harnessing them for learning purposes. Through the process they developed, students could create their own files, share them, and review them on their devices whenever and wherever they chose. These files consisted of narrated slides containing text and images, exported as movies and saved with specific file extensions compatible with a range of cellphones or other mobile devices, such as mp3 players. Students' frequent use and reuse of these files as part of their learning corresponds both with Bhattacherjee's (2001) exploration of why people continue to use certain digital technologies (continuance theory), and the comment Sørebø, Halvari, Gulli, and Kristiansen made that such technology "enables teachers and students with "possibilities", not with a "ready to use" resource" (2009, p. 1177). Students saw a possibility for learning through using their cellphones instead of computers which they didn't have. Through working with curious teachers as significant others, together they found a way to extend the affordances of these mobile devices.

The technology acceptance model/continuance theory that Bhattacherjee (2001) reported on, centred on customers of a bank's online banking system. This was, essentially, a one-way system where the bank designed an online banking system that customers remotely used. The bank wanted to know how likely it was that customers would continue using it. This was about ease of use, need and customer relations. In educational contexts, systems and technologies and/or affordances can also be readily adapted, but with student input. Also, a wide variety of technologies or affordances can be applied, according to elements such as context, topic, concept, student group, level and access. This differs from the singular approach or system a bank is most likely to create for customers, and links to Pachler et al's (2010) socio-cultural analysis vis a vis young people's continued use of digital technologies. Educationally, teachers are most likely to develop regular digital technology use in classrooms if students learning response is positive.

Many schools or even sometimes, subjects within schools, opt to ban mobile devices in classrooms. However, it is increasingly hard to sustain this position, especially when tablet devices and smartphones are showing their value in learning contexts internationally (Peachey, 2010; Valk, Rashid, & Elder, 2010). This closely links to the experiences of students as outlined above in the New Zealand secondary school, who were never without their cellphones. A socio-cultural ecology theory is developing, explaining how learners use mobile devices to frame their cultural and identity practices to make their way in the world. These aspects are defined as agency, cultural practices and structures and also link to ideas of appropriation – learners use these tools in ways they define for themselves (Pachler, 2010; Pachler, Cook & Bachmair, 2010). The New Zealand innovation summarised earlier is a case in point, particularly when students saw a need and worked to address it with the help of teachers. From that experience, the teachers observed striking learning behaviours – students, for example, were concentrating so hard on arguing about geographical concepts itemized on their files on their phones, that they bumped into school lockers, or, in another case, coming to blows over differences of opinion about geographic concepts.

Bhattacherjee (2001) and Sørebø et al. (2009) argue that the continued or prolonged use of any technology is conditional on its perceived value to those using it: if it works to help a person in their job, its use is repeated; if it works really well, its use is expanded and developed over time and it becomes part of their work identity. This suggests that users begin to think about how they can improve its use as part of their work. Teachers tend to be pragmatic - if something helps students learn, they will continue to use it and refine its use for learning over time, thus linking it to a teacher's professional identity. In other words, both the teacher and students will come to see the technology in relation to the teacher and the subject/topic. The aforementioned experimentation in one school is a case in point.

This paper suggests that both socio-cultural ecology theory and continuance theory can be applied to understanding mobile technology adoption in secondary school classrooms in a New Zealand school. Evidence points to students' agency and repeated use when it helps them learn and when they can create digital learning products. Also, teachers engaged in the study remarked on observing positive changes in students' learning behaviours when using digital tools (such as greater focus and concentration, task completion and, therefore, engagement), and this led to teachers as well as students, becoming keen to continue using these technologies/tools and expanding their use.

STUDY CONTEXT

The co-educational school involved in this project is situated in a large, urban, relatively well-off area. However, there are also pockets of socio-economic need and students from such families attend this school. A wide spectrum of cultures and background are represented, including a sizable number of new migrants and speakers of languages other than English or Maori. These were contingent factors the trial staff grappled with as it embarked on its mobile project. The Ministry of Education supported it by funding part of two staff members' time as leaders of the project, as well as money for the research and some capital expenditure. As the researcher, I was sub-contracted to the school for the research evaluation (Wright, 2010a, 2011). Four teachers and the IT Director were the core trial participants. Subjects included an English class, an English for Speakers of Other Language class, soft materials technology (cooking) classes, a senior Japanese class, and a geography class.

For the research evaluation, qualitative case study approach was used for a number of reasons. First, the evaluation had to be a snapshot within one calendar month of the four-month project. During that month, I spent two consecutive days each week in the school, conducting digitally recorded interviews with staff and students, attending relevant meetings, informal discussions with staff in the staffroom at break times, and observing classes. Note-making during observations, meetings and informal contexts during research visit days consisted of taking still photographs, short video clips and using the notes function on a mobile device. Pen and paper were also used occasionally to record information. Data were downloaded to my laptop. Seidel's (1998) process for qualitative data analysis was used each day, since during student interviews in particular, patterns emerged quickly. Seidel argues that noticing and thinking about what the data were saying as they were being collected are credible means for analysis-in-action meant that I was able to adjust questions asked of subsequent pairs of students, based on what previous pairs had commented on. This meant that data from student interviews began to focus on aspects of affordance, appropriation and their desire to use these mobile tools more often for learning, rather than just what was happening in the project classes. Second, because of the snapshot time period, quantitative measures of impact fell outside of the brief, although I was able to follow up with simple comparative assessment results collected by one teacher over a set of classes (two used the mobile devices and two didn't) for the full year. This was because the juniors (years 9-10; ages 13-14) had a one-term 'taster' option for the subject.

THE TEACHERS

Four teachers and the IT Director participated in the study. Brief profiles follow. The geography teacher was the prime initiator and co-director of the project with the IT Director. These two staff members were the ones involved in the initial experiment at the previous school. As the researcher, I spent more time with these two staff members than others, in order to probe their thinking, experiences, and how they handled the arising issues. This sometimes meant we had ad hoc 'brain dumping' interview sessions. This quickly became necessary because although the geography teacher was allocated time out of class to develop and manage this project, he was regularly called upon to help out with other teachers' queries about using mobile technologies. At the same time, he was still responsible for setting classwork while he was involved in this project, and sorting out discipline and pastoral care issues that arose. The IT Director was in a more difficult situation- he was unable to be replaced, so this project work practically occurred on top of managing the IT system, developing solutions to mLearning issues, providing information in assemblies to students about cyber safety and school protocols, and working with all staff to address IT issues as they arose. He also liaised with the telecommunications company to sort out mLearning bandwidth and capacity issues, as well as the Ministry of Education, and the Board of Trustees. At the same time, he supported teachers involved in the project in a number of ways. For example, he prepared the devices students brought to school to video food technology lessons, and created a model video for students, demonstrating what they might create for their assessment. His role straddled the school's leadership, IT infrastructure, external IT providers, and teachers' curriculum/learning needs. His focus was to navigate the IT provision to best meet teaching and learning needs, while being mindful of effective protocols to ensure the school modelled ethical practices for students. His own secondary teaching background was a fundamentally important factor in how he undertook his role.

The Food Technology teacher regularly experimented with learning design, aiming for students to achieve the best they could from learning experiences in her classroom. She, like the English/ESOL teacher, had been teaching for over 10 years, and, like her, was comfortable adding untried interventions to her practices in order to test their value for learners. Both of these teachers were lifelong learners, had improved their qualifications or were still in the process of doing so. The Japanese teacher had, the year before, experimented with creating content files for loading onto mobile devices, for example, to help students learn about the weather in that language. During the mLearning trial, senior students created their own files about giving directions in Japanese using the same model and process the teacher had used for the weather. This format was the same as used in the geography class. Student control and use of the technology featured strongly in this project, and were part of the learning design. It was not one where teachers pushed content to students; instead, teachers made it easy for students to create and share the digital/mobile learning products themselves.

In terms of continuance theory, which, while arising from business contexts and assumes that those adopting and using technology will do so repeatedly if they see it works to help their job, aspects appear relevant for educational contexts. In such contexts, the added dimension is student learning. Both students and teachers are most likely to continue using digital technologies if they make learning more interesting and engaging, easier, and effective. The correlation between tool/technology and individual use in school contexts is thus filtered by its learning value, rather than simply ease of use for task completion. Another filter is appropriation and its link with identity, understood as agency, cultural practices and structures as learners and teachers use these tools in ways they define for themselves and for the learning purposes (Pachler, 2010; Pachler, Cook & Bachmair, 2010).

FINDINGS

A literature review centred on e-learning and implications for teachers (Wright, 2010b) identified the potential of digital technologies to alter both teachers' pedagogies and their professional relationships with students. Students in the mLearning project found that using digital technologies and creating and sharing their own products enhanced their learning experiences, and precipitated frequent out-of-class use. As one student said, 'it stamps the learning in my mind' because the learning files are always accessible: she always has her mobile device handy. Out-of-class use of work in exercise books, for example, was non-existent by comparison. Students said they seldom reviewed anything in their exercise books while on the bus, nor did they show their parents what was in them. In contrast, they were keen to show their schoolwork stored on their mobile devices, and often reviewed these files in idle moments.

In the English for speakers of other languages class, and where the teacher trialled proprietary software and hardware that allowed students to use text-enabled hand-held devices to post answers to tiles on-screen that could be revealed alongside peers' answers, students reported the following. Overall, they:

- Liked seeing their answers to compare with their peers'
- Found the devices fast to use (they were like texting from their cellphones)
- Remained engaged and concentrated in the learning for long periods of time
- Liked the way the teacher examined and talked about the revealed student answers, seeking more information in a non-judgemental, but respectful way.
- Liked the democracy of all answers being seen (unlike a hands-up scenario, when only one or two students' answers were heard)
- Wanted to use the tool regularly, but not all lesson or all the time.

To summarise the mood and illustrate the level of concentration, one student (usually unable to settle except for very short periods of time) called out during a spelling quiz using the proprietary tools that, 'this is so much fun it doesn't feel like learning'. This student was also fully engaged with the content throughout the lesson. The key difference in the lesson was the intervention: the use of the technological tools.

In other classes where students used their own mobile devices, they reported that they:

- Wanted to use the devices more regularly across subjects – for example, to video their teachers creating equations on the board, so they could refer to the clip later as a revision/recall tool; to use notes functions to record ideas; to link to the internet without having to go to a computer lab
- Constantly referred to files already on their device, and wherever they were - on the bus, at break times, at home
- Shared their work more often with parents (compared to not sharing work in exercise books)
- Shared content files among themselves to supplement and complement their own work. This sharing linked to positive self-esteem and co-operation
- Thought their learning was 'faster' and,
- Were keen to continue to develop digitally-oriented work outside class times.

The above list illustrates Pachler (2010) and Pachler et al's, (2010) socio-cultural framing where students exhibit agency and appropriation within the cultural milieu of school. They demonstrated being in charge of their learning through using digital tools. Pachler et al's (2010) socio-cultural frame is a way of understanding what happens when digital technologies are inserted into educational contexts. It helps explain levels of co-operation and engagement. And when set beside continuance theory, demonstrates how the uptake of these technologies was likely to continue because the learners could see ways of using them regularly and across learning contexts: they could appropriate the technologies for their own learning purposes.

The teachers consistently noticed changes in students' concentration and willingness to continue learning outside timetabled lesson times, and noted a shift in how they, as teachers, worked with their students when they too were using technological tools as part of the learning. While all teachers in this project were experienced professionals and secure in their practices, they were acutely aware of the 'pain of failure' potential when using unknown and untried tools in their lessons. All took the view that experimenting with students to develop effective learning designs with new technological tools was not only healthy, but enhanced their teacher-student relationship. This can be attributed to not only seeking students' views about how these tools were helping their learning, but demonstrating that taking risks with learning new things was something that teachers did too. In essence, these experiments demonstrated the iceberg principle: that what is visible is only a small portion of the whole, for what has been prepared in advance links closely to the value of deliberate pedagogical design and collaboration. While Bhattacherjee (2001) argues that the technology acceptance model posits that "eventual success depend[s] on its continued use rather than first-time use" (p. 352), in educational contexts such as the mLearning ones described here, continued use rests with its perceived value for learning and ensuing enhanced pedagogical relationships.

In the observed classes, the IT Director was on hand to provide the necessary technical support for lessons to run smoothly. This was especially important when all parties were using an untried tool, or when students were bringing their own devices to use. Students were unconcerned about being part of this learning process; instead, they liked to help sort problems where they could. This collaboration in learning highlights staff-student relationships, and linked closely to co-constructive pedagogical frameworks that were nonetheless within contexts where the teachers had, and exercised, authority. Thus, the collaborative and collective inquiry did not undermine the teacher-student dynamic, but reinforced it because the boundaries about the rules of engagement remained clear. This dynamic is important – these teachers were deliberate in their choice of classes to wok with, and deliberate in their pedagogical dealings with their students. The mobile devices and affordances were an opportunity to insert something else into the learning, involving students in understanding what went on. At the same time, these teachers exercised their pedagogical authority and helped students remain secure and safe as learners. When students know what the acceptable boundaries are, makes it easier for teachers to not only initiate and undertake experiments in learning, but also invite students to provide feedback on it.

CONCLUSIONS

An oft-asserted view is that 'old' teachers are stuck and resistant to change. While there are always going to be resisters and the soon-to-be-retired in teaching, this generalisation hides what this project revealed as a key driver of success in this experiment with various mobile technologies and affordances. All teachers in this project probably belong in the 'old' demographic (as in having taught for more than 10 years each, or defined as middle-aged or older), yet all exhibited the opposite of resistance-to-change behaviour. They were open to experimentation and were very aware that the lessons could fail, since they had little prior knowledge or experience of using these technologies in their lessons. However, because they were experienced and keen to continually improve learning experiences, they were prepared to accept that 'failure' was an entirely possible result. This is a crucial finding. It suggested that these teachers were most likely to undertake experiments with digital technologies because they had already accepted what risking the unknown might bring. In other words, since they are pedagogically secure they can accept the potential for failure, because they can retrieve a situation and move on. This links closely to their ability to design learning with the fear of failure in mind: they have the necessary pedagogical nous to do so. This secure professional practice may be important if a technology acceptance model is to be applied to educational contexts, and highlights how important pedagogical content knowledge is to effective experimental practices with learning. Thus the continuance of mLearning practices is most likely to be coupled with teachers' decisions about students' reactions to using these tools. These are contextual and pedagogical purpose factors, as well as identity ones: teachers' professional identity is often linked to their relationships with their students. So, in educational contexts, continuance theory can be closely linked to teachers' existing confidence and competence, *and* their judgement of the extent to which any digital technologies enhance their students' learning experiences. It is also linked to the socio-cultural ecology aspects of agency and appropriation within the culture of both the learning organisation, and students' learning practices.

Finally, this mLearning project demonstrated that teachers were trialling *with* students, not *on* students (a probable point of difference from a bank, which necessarily trialled *on* customers). This difference in application of the theory of continuance is significant. The expectation-confirmation and continuance relationship in education is thus less about customer satisfaction and more about the perceived educational value to both teachers and learners. Continuance theory has potential to help us understand some of teachers' motivations in experimenting with digital/mobile technologies. However, context (education compared with business) and motivation heavily influence what matters, and how the tools are used, and this contextual/motivation factor, allied to the notion of agency, implies Pachler et al's (2010) socio-cultural framework. This framework proposes that individuals or groups will appropriate a technology or affordance for their own uses, and makes technological uptake more than about a system being used by customers or staff. Instead, it illustrates the importance of accounting for the influence of educational contexts, purposes and users' motivations where digital technologies are concerned.

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Context as Text in Mobile Digital Literacy: A European University Perspective

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ABSTRACT

The notion of digital literacy is rapidly gaining coherence and visibility as a major focus in UK universities and more widely in Europe for a cluster of non-subject-specific attitudes, skills and competences appropriate to digital societies. This paper argues that there is an obvious mobile component or addition to these and that this would a tactical improvement to the digital literacy agenda. A world characterised by near universal connection and movement does however pose a more serious and profound opportunity or challenge to this agenda, that of context as text and self as reader and writer. This paper reflects on a significant component of the socio-cultural context of mobile learning.

Author Keywords

Literacy, digital literacy

SOME BACKGROUND TO DIGITAL LITERACY

In order to explore the relationships between mobile learning and the growing discussions of digital literacy, we must first map out the general European digital literacy landscape. We will use the digital literacy agenda within UK higher education as a proxy for the wider European movement. Several sources (Beetham 2010; Belshaw 2011) review other European and international initiatives, programmes and endeavours that have run parallel to the UK discourses on digital literacy.

Within UK higher education, this agenda has over the last two years been driven and articulated by the e-learning programme within JISC (the Joint Information Services Committee, see, for example, http://www.jisc.ac.uk/whatwedo/projects/elearningllida.aspx, http://jiscdesignstudio.pbworks.com/w/page/46421608/Developing%20digital%20literacies, and http://www.jisc.ac.uk/whatwedo/programmes/elearning/developingdigitalliteracies/developingdigitalliteraciesprog.aspx)

. This has been an ambitious and coherent campaign to engage the UK higher education sector, from grass roots teaching staff to university managements, in discussion, development and publication, in order to formulate a consensus about the kinds of attitudes, skills and capabilities that students will need to have to get the full benefit of the technology and resources available to support their learning. A pragmatic approach to definition might be to see what we expect of these constituent capabilities, for example;

- "they are a pre-requisite or foundation for other capabilities;
- they are critical to an individual's life chances;
- they are essential to the making and sharing of culturally significant meanings;
- as a result, there is or should be a society-wide entitlement to these capabilities at some level." (Beetham 2010:1)

The programme has also documented the differing ways in which higher education institutions have defined and supported the acquisition of these skills and capabilities within their own briefs, and has sponsored projects to promote further development, publication and dissemination.

A handful of observations will suffice: firstly, the skills and capabilities related to the use, exploitation and potential of mobile devices are obviously only a subset of this larger agenda. It is however recognised that they represent an increasingly significant part of a diverse and changeable ecology of the various digital technologies that might support learning but importantly a part where the loci of control and confidence has shifted away from lecturers within the temporal and spatial bounds of their institutions and towards their students, often outside the bounds of the institutions. This shift means that supporting an institutional digital literacy agenda will transform the roles and responsibilities of teachers and lecturers, expanding these from just being authoritative subject experts facilitating transmissive and discursive learning to include learning *with* or even *from* their students. The capacity of these technologies inside the broader web2.0 ideology means that embraces the *ends* as well as the *means* of learning, the *what* as well as the *how*.

Secondly, the larger agenda represents an attempt to formulate a portfolio of comprehensive and generic attributes that might characterise graduates leaving colleges and universities in the coming years. The discussions within this emergent European digital literacy community have resonated with other older discussions across the higher education sector about the nature of so-called *graduate attributes* or even *graduate-ness*, part of an attempt to pin down the broad but defining features of the European university experience and the nature of its *added value*. All of these various discussions have managed to define quite succinctly those attributes that relate to employment and employability but have struggled to be quite so precise about those other attributes that could characterise the digitally literate graduate in varied social, civic, cultural, political and community settings.

Thirdly, the digital literacy discussions have also been informed and influenced by earlier discussions about digital safety and digital rights. The implication is that being digitally literate implies making ethically informed choices and decisions about digital behaviour, for example about digital property, digital identity and digital privacy. The digital literacy discussions have been further skewed or confused by the exact role and significance of basic IT skills. These are clearly important attributes but because of their concrete and utilitarian nature, they are easy to define, perhaps at the expense of attributes that are more abstract or more fluid. Other attributes can be grouped under the headings attributes and practices, and depend on access, creating a hierarchy of abstraction or dependencies.

Attribute	'I am…'
Practices	'I do….'
Skills	'I can …'
Access	'I have ...'

(Beetham and Sharpe, 2009)

Lastly, the digital literacy discussions have also, however inappropriately, drawn on the terminology and literature of *digital natives* and *digital immigrants* (Prensky, 2001), implying that digital literacy may be a generational attribute. There are also consequences, in defining digital literacy, for definitions of *digital divides* and notions of *digital inclusion*. All three have their respective implications for ideas about entitlement and equity. Digital literacy is also a cultural attribute resting on the notions of literacy, learning, education and knowledge local albeit often tacitly to a specific culture or sub-culture. One of the challenges for educators is the increasing fluidity and confusion as more cultures and sub-cultures emerge in cyberspace and *phonespace*, orthogonal to those in geographical space (Traxler, 2012).

Clearly, these discussions about the nature of digital literacy are neither clear-cut nor isolated from other discussions about students and studying in any wider social and technological context. They are often pragmatic and concrete, intended to inform policy, priorities and practice, and do not always make explicit contact with the notions of literacy itself, with reading and writing, and consequently with the changed meaning of reading and writing in a digital world. This world is being transformed and populated by more and more digital means of communication, comprehension and expression.

MOBILE LEARNING AND MOBILE DIGITAL LITERACY

This brief account of digital literacy in general is intended to introduce the idea of *mobile digital literacy* and thus ask whether such a phrase has any meaning, value and significance. An obvious response would be to re-enact the earlier account but now prefixed with the extra adjective *mobile*. This would be superficially satisfying and would no doubt assert that there are a set of skills and capabilities related to living and functioning in a world of mobile digital devices. A more rigorous approach however is to look at the nature of literacy and ask whether the activities of communication, comprehension and expression are being transformed by specifically *mobile* digital technologies.

Literacy is a component and a foundation of many different types of learning, irrespective of how these terms are defined. Consequently, we can assume that digital literacy is a component and a foundation of many different types of digital learning - or *e-learning* to use the conventional term. Mobile learning - or *mobile e-learning*, to give it a fuller name – is a new way of reading and writing the existing curriculum, within the existing education system, a way opened up by mobile devices. These devices allow access for readers who were previously too distant, too geographically, socially, physiologically, infrastructurally, culturally or economically distant from the other kinds of educational reading and who thanks to mobile technology could now be brought into the community of academic readership. These devices also enhance or enrich the nature of the academic text, creating the opportunity to read and write richer texts from that curriculum. These two claims can be elaborated (Traxler 2008a) but both are in theory predicated on a foundation of mobile digital literacy. Mobile learning leaves the fundamental ideas of the *reader* and the *read* untouched and unchanged. Examining mobile learning may allow us to explore the nature of this mobile digital literacy but this is however to view mobile learning and mobile digital literacy in a rather artificial context, as academic practices confined to educational institutions. Furthermore, the only sustainable way forward for most mobile learning initiatives is to exploit *learner devices* (Traxler 2010) or *BYOD*, *bring-your-own-device* (CoSN, 2012), the devices students already own and use. The implication is that sustainable mobile learning must be based on students' existing skill-sets, based on their own devices, and that this defines their mobile digital literacy but must also be a durable foundation for their mobile lifelong learning. There is thus a dynamic between digital literacy as seen from the *top-down* of the institutions and seen from the *outside-in.*

We argue elsewhere (Traxler 2010b) that this is no longer an adequate or appropriate frame of reference since the whole social and cultural context of learning (and its economic significance) is being transformed by the movement and connectedness afforded by universal personal mobile technologies. In this paper, we take this argument further and argue specifically that the impact of the powerful technologies of context undermine the stable dichotomy between the *reader* and the *read*, and thus challenge the earlier definitions of literacy, predicated on this apparently stable and obvious dichotomy.

NO LONGER THE READER AND THE READ

Context has been defined and classified in a variety of different ways. Working definitions might be, "the formal or informal setting in which a situation occurs; it can include many aspects or dimensions, such as environment, social activity, goals or tasks of groups and individuals; time (year/month/day)." (Brown 2010:7) or "any information that can be used to characterize the situation of an entity, where an entity can be a person, place, or physical or computational object" and thus, context-awareness or context-aware computing is "the use of context to provide task-relevant information and/or services to a user" (Dey & Abowd, 1999:1), ''typically the location, identity and state of people, groups, and computational and physical objects''. Popular and powerful retail mobile technologies now routinely sense aspects of context, usually time, location, orientation and inclination in a variety of frames of reference but in terms of the current formulation, the context was always the *read*, the *text*, it was *outside*, it was *other*, it was the container of the *reader.*

Context now has an increasingly rich meaning within the mobile learning research community and is used to describe processes by which learning can be enhanced with ideas, images and information that are somehow contextual. In the early days, for example, the *MOBIlearn* project, this context of the learner and their learning originally meant merely the spatial and temporal context. The time and place of the learning and the learner, and their mobile device, would trigger images and information that would enhance their learning. Practical considerations of technology and resource usually meant this was severely bounded in space, for example to the confines of a museum building, heritage site or cultural venue, and likewise bounded in time, to the duration of the visit of the individual learner. The technology would nevertheless be able to make increasingly better inferences about the learner's interests as the history of the episode built up and would react accordingly by providing more personalised images and information. In context-aware mobile learning, these interactions might take the form of oral and social history; artistic, expressive, creative and literary creations; reviews, responses and reactions to the environment, all specific to the locality and the context, all specific to their creators. They could clearly also be cumulative and iterative, reactions triggered by reactions, recollections triggered by recollections.

The subsequent trajectory of exploiting context in learning could exploit social context, namely the learner's social circle, and *user-generated contexts*, namely, what the learner brings with them to the external context, that is their preferences, values, knowledge and history. The distinction between the learner and their context has been eroded by the notion of *user-generated contexts* (Cook, 2010), the concept named to emphasise the role of learners themselves in shaping their own context, "the context within which communication takes place is augmented by users to suit the needs of the individual and/or the conversational community" (Cook *et al.,* 2010:4). We can also embrace the Web2.0 ideologies and technologies, those that transform learners from merely the readers and consumers of information, ideas and images to the writers and producers of them, and also transform the nature of their identities into multiple and mutable forms.

This weakens the notion that context is a passive *text*, merely to be *read,* separate and distinct from the *reader.* A more radical and comprehensive account of mobiles in society takes this further. The ideas and practice of context-aware mobile learning came, however, out of a particular historical and social milieu. They were embedded within the mobile learning research community and seen as a major development and contribution to the wider field of technology-enhanced learning. The last three or four years have however seen a rapid change in the ownership of powerful personal digital technologies for learning. This significantly changes the locus of the discussion.

Several authors (such as Nyíri, 2007; Traxler, 2008b; Plant, 2001; Ling, 2004; Fortunati 2004; Goggin 2006; Geser, 2004) have argued that the mobility and connectedness afforded by these devices are implicated in profound changes in our understanding of space, place and time; on identity, presence and community; and on learning, understanding and knowing. There is a resonance here with the various positions of *post-modernism,* specifically *post-structuralism,* and these undermine the simple and apparently intuitive dichotomies of the *self* and its *context*, between *subject* and *object*, the *reader* and the *read* of the digital literacy discussion because they assert that language rather faithfully recording and representing reality actually colludes to its construction.

Our interest is specifically with the contextual and associated technologies and their impact. One of the consequences of context-aware technologies is to dilute the *here-and-now* (Traxler 2011). The growing number of augmented reality applications adds to the dilution of the immediate experience of the *here-and-now* context, the *read* is becoming less tangible and fixed. Mobility and connection are also amongst the factors changing individuals and their identities, and the nature of communities. The rise of networked technologies has led to far more complex ideas about identity, both formally, in relation to *official* network technologies, and informally, in relation to social network, and thus what constitutes the user, the *reader*, as opposed to their context, the *read*, changes and blurs. Mobile devices affect the processes by which ideas, images, information and knowledge, and hence informal learning, are *written*, produced, stored, evaluated, valorised, distributed, delivered, consumed and *read*. These become more popular and demotic. They are now part of a system that allows everyone, including learners and potential learners, to *write*, generate and transmit content for learning, not just passively *read*, store and consume it, making mobile systems an integral part of the Web2.0 ideology that takes users from merely the Web's readers to its writers. The impact of mobility and connectedness on knowledge and reading is to make them far more obviously relative, local, transient and partial.

Knowledge and *text* are local in being local to a community, local in being location-specific, produced locally and consumed with defined communities, not necessarily geographically or spatially defined communities, nor authoritative, universal and canonical. The informational context, and hence the *text*, is no longer fixed, monolithic and external. (Traxler, 2011) This has implications for the hierarchy, and status of different writing genres, and their equivalents in cyberspace and *phonespace*

THE READER IS THE READ

We have explored a range of factors derived from the social impact of mobile technologies that, within a European context, are complicating and enriching the notion of literacy and specifically digital literacy. This may be analogous to earlier transformations of the same notion within a European context as it evolves under the impact of each new technology. Our position is that the notion of digital literacy becomes fragmentary and contested; mobile technologies do not merely enrich or extend the reading and the readership of the digital world about us but to fundamentally trouble the notions of the reader and the read, replacing stable and intuitive boundaries with more fluid, partial and contingent ones.

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iPad Professional Development Program (iPDP)

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ABSTRACT
Scholars who have studied the adoption of technology in educational settings, believe that professional development is necessary for its successful adoption. This paper addresses a need for an iPad Professional Development Program (iPDP) to support the adoption of iPad tablet computers in higher education teaching and learning. The proposed iPDP is a hybrid program involving both face-to-face learner interventions and online resources. The program is made up of three interrelated components: (a) an online resource that supports the entire program, (b) an introductory workshop (iPadogogy) targeted at pre-adoption learners; and, (c) a knowledge-sharing event targeted at all learners. This paper describes: the components of an iPDP; the design considerations for each of the components; and, the limitation of the proposed iPDP.

Author Keywords
iPad, tablet, higher education, mobile learning, professional development, educational development, academic development, learning technology, adult education

INTRODUCTION
The purpose of this paper is to describe an adaptable professional development program to support the adoption of iPad tablet computers in higher education teaching and learning. By *higher education*, I mean post-secondary education, such as college or university, and *teaching practice* refers to all activities performed by teachers in the administration, preparation, delivery, and evaluation of instruction. In this paper, the term "iPDP" refers to an iPad Professional Development Program. This paper proposes an iPDP by describing: the components of an iPDP; the design considerations for each of the components; and, the limitation of the proposed iPDP.

Technology adoption refers to an individual's acceptance of a technology, while *diffusion* refers to the adoption of a technology across an organization (Rogers, 2003; Straub, 2009). Scholars who have studied the adoption of technology in educational settings, believe that professional development is necessary for its successful adoption (Brown, Benson, & Uhde, 2004; Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004; Keengwe, Kidd, & Kyei-Blankson, 2008). Even with well-publicized technology, such as the iPad, providing access alone has not proven to be sufficient for successful adoption (Georgina & Hosford, 2009; King, 2002; van Oostveen, Muirhead, & Goodman, 2011). Moreover, if early adopters of a technology have negative experiences, their experiences "may lead to skepticism among the early majority" (Moser, 2007, p. 67).

The proposed iPDP addresses the need for professional development to support the adoption of iPad technology in higher education teaching and learning. The iPDP has three components: (a) an online resource, (b) an introductory workshop, and (c) a knowledge-sharing event. The components of the iPDP are influenced by the academic literature on technology adoption, faculty development, and learning theory, as well as the unique characteristics of the iPad technology. The intended outcome of an iPDP is the increased adoption of iPads into teaching and learning practice.

THE IPDP FRAMEWORK
The primary goal of the iPDP is to increase the adoption of the iPad among higher education teachers for the purposes of supporting teaching and learning. The iPDP is not intended to address a single context; rather, it is intended to be adaptable across academic organizations. For the purposes of the iPDP, I define two levels of learners: *pre-adoption learners* are those who do not yet use their iPads to support professional practice, and *post-adoption learners* are those who do use their iPads in some form or another to support professional practice. The iPDP benefits both pre-adoption learners and post-adoption learners.

The iPDP represents an ongoing program, rather than a one-time intervention, as recommended by Lawless & Pellegrino (2007): "the best professional development activities are spread out over time with opportunities for follow-up learning and feedback" (p.594). The iPDP is hybrid in nature, in that it involves both face-to-face interventions and online resources. It is made up of three interrelated components (see Figure 1): (a) an online resource that supports the entire program, (b) an introductory workshop (iPadogogy) targeted at pre-adoption learners, and (c) a knowledge-sharing event targeted at all learners.

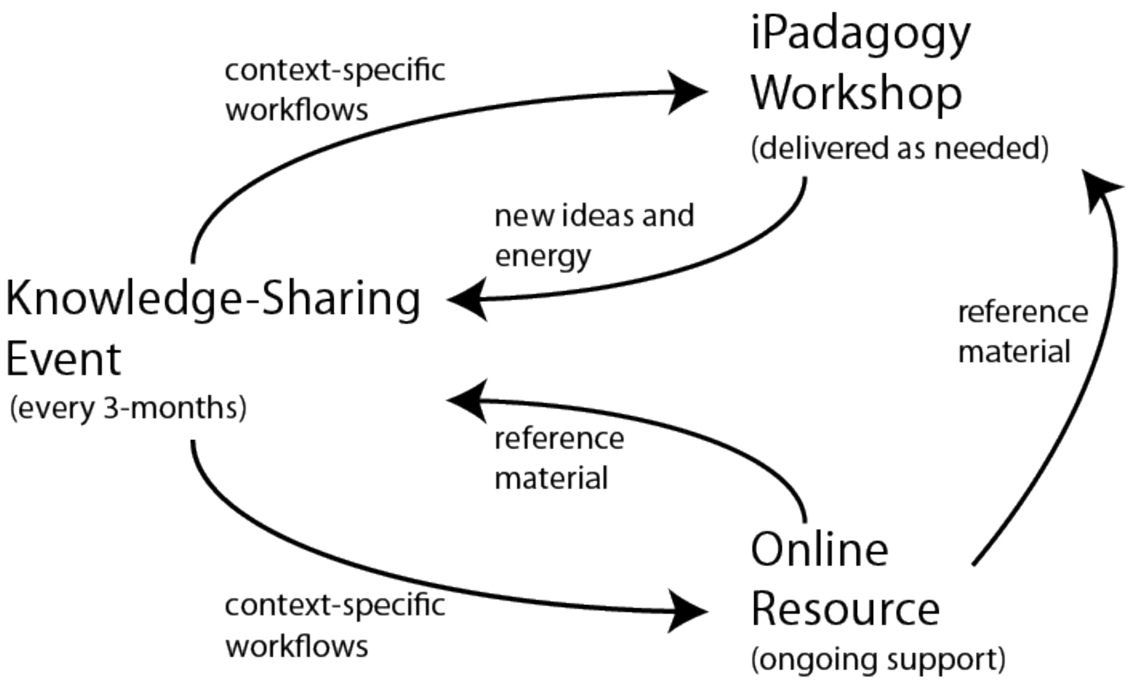

Figure 1. Proposed iPDP framework

DESIGN CONSIDERATIONS

The interconnection between the components provides a mechanism for harvesting context specific workflows from the Knowledge-Sharing event, for the purpose of integrating these workflows in both the iPadagogy Workshop and the Online Resource. *Workflows* are descriptions of processes that include a detailed sequence of steps indicating how to perform a specific task. Workflows describe how to use the technology in a specific context rather than describing the product features. The interconnection also allows for new ideas and energy to be injected in the Knowledge-Sharing Event as learners graduate from the iPadagogy Workshop bringing familiarity with recent updates to the technology. The regular frequency of the iPad Knowledge-Sharing Event, and the interconnection, provides a mechanism for ensuring that that the iPDP adapts to the fast-pace of change in the ever-evolving iPad technology.

Design considerations for the iPDP were drawn from: the scholarly literature on faculty development, and learning theory; the author's professional experience; and, the unique characteristics of the iPad technology. In the following sections, I describe the specific design considerations of each component.

Design Considerations For The Online Resource

The Online Resource serves two purposes: to support the iPadagogy workshop and Knowledge-Sharing events, and to provide a sense of on-going presence and support for learners. The Online Resource is a dynamic website designed using the current best practices for website usability. The website may be accessed by the learner on both a desktop computer and an iPad. The website provides reference material that promotes and supports the use of the iPad as a tool for teaching. It is updated regularly to ensure that learners are reminded about the use of iPads in practice, and to provide answers to common learner questions in a timely manner. Regular updates also provide a sense of social presence, which is necessary for both successful online learning (Garrison & Arbaugh, 2007) and for learners to feel ongoing support, which is necessary for the adoption process (Lawless & Pellegrino, 2007).

At a minimum, the online resource includes: (a) links to resources providing basic instruction on how to use the iPad, (b) problem-based activities to challenge the learner, and (c) organization specific workflows. Content for the online resource is obtained through multiple sources, including: curating links to existing Internet resources, creating specific activities to support iPad use in the context of higher education teaching, and harvesting organization specific workflows from the iPDP Knowledge-Sharing event.

The frequency of updates to the online resource presents a balancing act between the desire to support a sense of presence by providing regular updates and the economic impacts (direct cost and labour) necessary to maintain the site.

Design Considerations For The Introductory Workshop (iPadagogy)

The iPadagogy Workshop is a face-to-face 90-minute or half-day workshop intended to increase pre-adoption learners perceptions regarding how useful the iPad is and how easy the iPad is to use. The name of the workshop is a play on the words iPad and pedagogy, and was chosen to reflect the workshop's emphasis on teaching practice. The word "introduction" was intentionally removed from the workshop title as it carries with it a stigma that may prevent pre-adoption learners from attending. The iPadagogy workshop is offered whenever there are enough pre-adoption learners to justify it.

The key factor that differentiates pre-adoption and post-adoption learners is that the pre-adoption learners do not yet perceive value or benefit from using the technology (Spotts, 1999). In addition, research on technology adoption indicates that increasing a user's perception of the usefulness of the technology and ease-of-use of the technology increases the likelihood of adoption (Davis, Bagozzi, & Warshaw, 1989). Thus, the purpose of the iPadagogy workshop is to provide learners with an appreciation for the usefulness of the iPad as a tool to support teaching practice, and to increase learners' familiarity with the device such that they find it easier to use. Throughout the workshop, learners work in small groups to solve educational challenges using their iPads.

Throughout the workshop learners are provided with concrete examples of how to use the device to support teaching and learning within their context. For example: using the iPad to mark assignments with a PDF annotation app, synchronizing files between the iPad and classroom network, and using the iPad to control what is displayed on the classroom projector.

The content of the workshop draws upon problem-based learning and collaborative learning teaching strategies. In problem-based learning, learners work in small groups to solve authentic problems, that is, problems where the cognitive demands closely resemble what the learners would face within a real-world context. Learners are encouraged to seek out whatever resources are necessary to solve the problem, similar to real-world problems there is no one correct solution (Savery & Duffy, 1995).

In the iPadagogy workshop, learners work in small groups to address problem-based activities that are incremental in their complexity, beginning with activities that are designed to instill confidence in the learner's abilities. Early activities involve simple problems that relate directly to tasks that the learner is already familiar with, such as sending email or looking up references on the Internet (Brown et al., 2004; Ertmer, 2005). Activities then progress in complexity and become more context specific, challenging the learner to gain new skills with the device while demonstrating context specific uses.

In addition to problem-based learning activities, post-adoption learners are invited to present common workflows, specific to the organization. Finally, the workshop ends by "encouraging participants to leave the workshop with an immediate goal to implement the new skill in practice" (Georgina & Olson, 2008, p. 7). In the case of the iPadagogy workshop, the participants will be challenged to contribute at the next iPad Knowledge-Sharing event.

Design Considerations For The Knowledge-Sharing Event

The Knowledge-Sharing event is a 60, 90 or 120-minute collaborative learning experience, intended to enhance the learners' use of the iPad in their teaching practice. Throughout the event, learners work in small groups demonstrating to one another how they are currently using their iPads to support their teaching practice. Rogers (2003) emphasizes that "more than anything else, it was the social power of peers talking to peers about the innovation that led to adoption of the new idea" (p.68). Thus, the Knowledge-Sharing event is a collaborative learning event, taking advantage of the social power of peers, where learners demonstrate how they use the iPad within the context of their specific organization.

The ways in which the iPad can be used changes very quickly as new and improved applications become available in the App Store. One unique feature of the iPad is that new users often have a more recent perspective on the ever-changing capabilities of the technology (applications and operating system) than the more experienced users. This means that both new and experienced users can equally contribute to the collaboration in the Knowledge-Sharing event. Also, because of the fast pace of change of the iPad technology, the Knowledge-Sharing event is repeated every three months.

Learners who discover one way of doing things risk becoming complacent with the limited use of the technology. The Knowledge-Sharing event mitigates "the inherent danger that a teacher will become prematurely satisfied with their limited use of the technology" (Hooper & Rieber, 1995, p. 157), by disrupting those who have become comfortable using the devices in a limited capacity and providing them with encouragement to explore new and improved ways of doing things. The introduction of new ideas at regular intervals also helps to moderate the effect that prior similar adoption is negatively correlated with technology use, as learners who have adopted a similar technology may not see enough incremental benefit for changing their existing practice (Straub, 2009).

Finally, the workshop supports those who are still trying to figure out how the iPad can be used to support teaching and learning within their specific context.

LIMITATIONS

An iPDP cannot address everything that is necessary to increase technology adoption. The proposed iPDP only addresses the aspects of technology adoption that can be influenced by educational interventions. As such, the iPDP does not address organizational issues, such as those relating to the marginalization of teaching within the academic career reward system (Kim, Horton, & Amelink, 2011; Schneckenberg, 2009). In addition, the iPDP assumes voluntary adoption and it assumes that the learners in the program are at different stages of adoption. Finally, the proposed iPDP focuses only on the design of the iPDP, and as such, it does not address evaluation of the program itself.

CONCLUSION

In this paper, I propose an iPDP that addresses a need for a program describing professional development to support the adoption of iPad tablet computers in higher education teaching and learning. The proposed iPDP consists of three interconnected components: (a) an online resource that supports the entire program, (b) an introductory workshop (iPadagogy) targeted at pre-adoption learners, and (c) a repeating knowledge-sharing event targeted at all learners.

Future research, in the form of a design-based research study, is planned to validate this program across multiple higher education institutions. This future research will seek to validate the program and provide instructional-design notes to assist in adoption of the program across organizations.

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Building Mobile Learning Capacity in Higher Education: E-books and iPads®

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ABSTRACT

The growing popularity of e-books, e-book readers and tablet devices is forcing a reappraisal of the various functions of 'the book' in education. Furthermore, e-books are becoming a more salient element in the ecology of mobile learning, as new devices make reading a more comfortable and sociable experience. We report on the results of an 18-month project (2010-12) undertaken as part of The Open University's Building Mobile Learning Capacity initiative. The project introduced a group of Associate Lecturers to interactive e-books produced by the university and to the iPads® on which they could be accessed. The proliferation of increasingly interactive e-books and e-book collections calls for an examination of their evolving pedagogical purposes; an important aim of the project was therefore to enable this group to form ideas of how these resources could be incorporated in distance education and professional development of academic staff/faculty. The project used surveys, focus group meetings, online forum postings, blog posts and wikis to enable participants to record their experiences and ideas. One project output has been the identification of a spiral of six key use case areas for e-books. In particular, the categories 'situational reading', 'collaborative/group learning' and 'e-book production' inspired a collaboratively designed group activity for a face-to-face outdoor tutorial, which was trialled and is described in this paper. The experience has relevance for the design of blended learning as well as for mobile learning activities in many other settings.

Author Keywords

e-book pedagogy, collaborative learning, situated learning, academic staff development, distance education

INTRODUCTION

E-books are increasingly popular and have a perceived value as relatively low-cost, easily accessible resources in education. However, a compelling pedagogical rationale and methodology for their adoption is yet to be fully articulated. In this paper we look at how innovative learning can be achieved through a shared exploration of e-books and iPads® among a group of academic staff (faculty) in Higher Education who are interested in changing their teaching and student support practices. We report on the results of an 18 month project (2010-12) led by The Institute of Educational Technology (IET) at The Open University, UK, as part of the university's strategic Building Mobile Learning Capacity initiative. This initiative has been exploiting Apple's iPads®, which are acknowledged to be a popular colour tablet device, used for many purposes including commonly as an e-book reader. The project has focused on the academic value of both the iPads® and a variety of academic e-books that can be read on these devices, although we have also included use of the iPad® for leisure activities and to address workflow productivity. We have identified innovative uses of e-books and tablet computers in various learning situations and consider the implications for the design of new learning materials, activities and programmes.

In 2010, The Open University was one of the first universities worldwide to make its in-house developed interactive e-books available on iTunes U®, and it continues to innovate in this area. Over the past decade, the university's Institute of Educational Technology has developed expertise in pedagogical and usability evaluations of e-book use alongside other research in reading and mobile learning (e.g. Waycott & Kukulska-Hulme, 2003; Twining *et al*., 2005; Kukulska-Hulme, 2005; Kukulska-Hulme & Pettit, 2009; Kukulska-Hulme *et al*., 2011). The current project also draws on technological innovation from the university's Knowledge Media Institute, and the Learning and Teaching Solutions unit where new learning systems are developed and supported. One key finding from our previous research is that e-books on portable devices fit in well with the lifestyle needs of distance education students, who often combine work with study; furthermore, reading e-books and academic papers on personal mobile devices is already a fairly popular activity among Masters level students (Kukulska-Hulme *et al*., 2011). Similarly, Nie *et al*. (2011) have found that work-based distance education students appreciated the flexibility and improved use of available time that e-books can offer. Indeed, studies on e-book use in education have largely focused on students' perspectives rather than those of their teachers. However, student experiences have not been uniformly positive. Woody, Daniel & Baker's (2010) research suggested that students prefer printed textbooks to e-books, while Cutshall, Mollick & Bland's (2009) work indicated the need to break content up into smaller chunks to match it to students' Internet reading habits formed through the use of social networking. A survey conducted by Foasberg (2011) concluded that a very small proportion of students use e-readers, with price being the greatest barrier to e-reader adoption. A study by Kang, Wang & Lin (2009) reported that reading an e-book causes significantly higher eye fatigue than reading a conventional book, while Lam *et al*. (2010) have noted significant challenges in the technology itself and the approaches needed in the pre-reading process of finding and downloading e-books. Therefore issues of design, usability and costs are important factors in decisions about adoption of e-books and e-book readers, but interface and content designs are rapidly evolving and costs are falling.

Research on educators' perspectives currently delivers reports based on opinions about advantages and disadvantages (e.g. Jamali, Nicholas & Rowlands, 2009; Bierman, Ortega & Rupp-Serrano, 2010). However, if teachers have little or no direct experience of using e-books and e-book readers, there is a risk that they will not be able to support their students or design appropriate resources and activities for them. For this reason, we resolved to work together with a group of academics for whom experimentation with e-books and iPads® represents not only an opportunity to develop their teaching, but also a new way to engage with personal and professional development Kukulska-Hulme (2012). As part of this professional development, academics can begin to reflect on their pedagogical approach and how this might need to evolve or change to accommodate e-books as part of a repertoire of educational resources and a possible focus for active and social learning. In particular, interactive e-books and e-book collections invite a re-examination of their evolving pedagogical purposes. Furthermore, Weller's 'pedagogy of abundance' (Weller, 2011) suggests the need for new learning models which assume easy access to multiple learning resources. We propose that e-books may be conceptualized in various ways, for example as new cognitive tools that exploit multimedia capabilities to engage and reinforce learning; as social tools enabling community-building through sharing or collaborative annotation; as a further step towards greater inclusion and accessibility; or as part of an emerging industry of self-publishing and disaggregated content.

In the next section we describe our method of working with the academic staff involved in our project and present their experiences with using interactive e-books on iPads® .

ANALYSIS OF THE ASSOCIATE LECTURER EXPERIENCE

As an integral part of the project, 12 Associate Lecturers (AL) were given wifi enabled iPads® in March 2011 to experiment with as potential tools to support teaching and learning. In addition a closed forum was set up in the Open University Virtual Learning Environment for them to share their experiences of setting up and getting familiar with the devices and to share their experiments of using them for teaching and learning. Each tutor was also given a personal blog which was only viewable to themselves and the project leaders to help them document their experiences. The twelve Associate Lecturers came from a wide range of disciplines.

In June 2011 they were sent an online survey to complete for the project team to capture and evaluate their views on the iPad® as an e-book reader and teaching tool. The survey was not anonymous and the results were shared for discussion with the associate lecturers in the group. In May 2012 they were sent a second online survey, to evaluate their views after more than a year of using the iPad®. The data from this second survey have now been collected and a full analysis of the data is being conducted. Some of the initial findings are of interest – ALs are now using the iPads® much more in public in a mobile capacity and also for work purposes in family space so as not to miss out on family time. Over the period, there was increased use of the iPads® as e-book readers although there was less use made of the Apple iBooks store and more use of copyright free materials. The ALs also report the iPad® as becoming a much more integrated tool in their daily lives and that for some it had changed their work practice and thinking.

In addition to these surveys, we were able to draw on focus group meetings, 18 months of online forum postings and blog posts in an online community, as well as wikis created during the project. This approach enabled a good degree of triangulation and the opportunity for participants to enter a cycle of reflection on their experiences. Through these data, we have identified six key use cases which need to be considered for e-book use (for pedagogical guidelines arising from these uses and a fuller analysis of the data, see Smith, Kukulska-Hulme & Page, in press). These six aspects can be represented as a widening spiral of activity symbolising the user's transition from novice - exploring the intrinsic features of e-books, through to expert - academics producing their own e-books. The user's journey begins with basic e-book use and exploring functionality, they then might move onto using the e-book in a range of locations, perhaps initially for simply reading and then for learning. From using one e-book, the user then begins to use multiple resources and from working alone they may move on to work collaboratively. The final phase of the journey is when the academic produces their own e-books.

Basic E-book Use

Many of the standard e-book features are valuable additions to academic texts, particularly the ability to resize text and images. Bookmarking and annotation are also commonly seen in e-books but often they are very simple and do not 'talk' to other packages. The availability of even simple searching replaces to a large extent the need for a detailed index – however, searching on concept terms will still be an important element of academic texts and will need to be retained. Authors need to bear in mind that not all e-book reader devices are able to render colour, let alone interactive features. However, the motivating potential of including multimedia elements into their e-books should not be underestimated.

Situational Reading

The most important aspect of e-books is their portability, since e-books can be carried and read regardless of their size and weight. For academic texts this is a significant advantage of e-books. Also when available, internet access allows for just in time downloading and use. 'Situational reading' takes place when one or more books with desired content are easily available to learners when needed, thus matching readers' requirements in relation to the situation they are in. Traditionally, popular books sold at airports are well matched to what many people like to read on a flight or on holiday. Situations associated with mobile reading can include a daily commute on the bus or train, a field trip or a gallery tour.

E-books and Learning

An e-book can contain all of the resources needed by a student in one bundle. As a distance learning provider, The Open University often asks students to read print based texts, watch videos, access the internet and take part in online forum discussions – all of these can be combined into a single e-book. Often the contents pages allow the student to jump directly to a page and to bookmark it. However, e-books do present problems, since academic texts need to have more sophisticated annotation facilities including the easy export of notes and annotations to other packages without further extensive editing. Furthermore, we did not come across any easy mechanisms for producing page references in any absolute manner. Taking set texts into examinations is also problematic at the moment with e-books.

Using Multiple Learning Resources

Academic study often requires the student to have several resources open at once and here there are difficulties with e-books. Switching from one e-book to another effortlessly is vital but many e-book readers require one book to be closed before another can be opened. Annotation over several e-books requires the student to go outside of the e-books themselves and use, for example, a separate word processing package. From our current study we do not see any developments in the market to address this issue.

Collaborative/Group Learning

Once in digital format, learning resources can be relatively easily accessed on a range of devices. As part of our project we had available a pool of iPads® for group usage but students in addition made use of their own devices – such as smartphones and laptops. However, one device per person was not necessary; during the project several group activities were carried out and depending on the particular activity up to 4 people could work with a single iPad®.

E-book Production

The Open University produces a large number of bespoke e-books for its modules. However, with the availability of relatively simple and cheap software for e-book creation, e-books can be produced by individual Associate Lecturers allowing them to assemble their teaching materials into a single package for their students. During the project we have experimented with a number of e-book creation packages both for PCs and iPad® apps.

CASE STUDY: COLLABORATIVELY CREATED SITUATED LEARNING

Whenever a new tool or technology comes along there is the potential for disruption to the existing order. This disruption comes in two forms: new tools can enable us to do the same things but in different ways, but they can also enable us to do different things. Mobile learning on field trips is a prime example; e.g. in geosciences mobile technology enables collection of geo-referenced data and immediate analysis and visualization in situ (Beddall-Hill and Raper, 2010).

A number of activities emerged in the course of the project but the highlight was through the work of a small group of ALs who devised and implemented an innovative blended learning activity. This comprised a group of students and tutors using wi-fi enabled iPads® walking around a small town working in pairs and making use of pre-loaded material on the iPads®, wi-fi for web access, and collaborative online forum work along with a bespoke e-book created by the ALs themselves for this activity. The whole process was filmed as it happened and will be the subject of a future multi-media report. This single activity was a result of the tutors themselves having made the transition from novice to expert and in the course of the activity the students also encountered the first five key use case aspects.

The aim of the activity was to summarise the multiple strands of one of the Open University's core foundation Arts modules to aid the students' understanding and appreciation of the whole sweep of the module. The module required 600 hours of student work over a 9 month period. The ALs identified a core set of ideas from the module and they created their own e-book using Sigil, a free open source package although they had also experimented with a number of e-book creator apps on the iPad®. They structured a 'walking tour' around the town which had been used as the location of a popular TV drama series – familiar to most of the participants. The students worked in pairs using the iPads® as readers for the bespoke e-book and as a link to the internet, to both collect more information and to engage with an online forum to share ideas – created for the activity and accessible to all of the students on the module and not just those who participated on the day. As the group moved around the town – stopping at key points to view the e-book and to discuss the various issues, they had internet access through the use of mi-fi devices – small mobile devices that act as wi-fi hotspots as well as wi-fi connectivity available from cafes and so on. This single event shows the synergy achievable through the use of quickly produced e-books used in situ with internet connectivity to create a rich and relevant learning environment. One of the products from the project is to feed these experiences back to module teams to inform their thinking for future modules.

CONCLUSIONS

We have produced a considerable resource of data about academics' use of iPads® spanning the period from their being novice users through to becoming sophisticated users of e-books and iPads®. We have identified a number of issues that still need to be addressed by the e-book industry and a number of issues which academic e-book producers need to be aware of when designing e-books. However, we have shown that when combined synergistically, the functionality, portability and comprehensiveness of resources offered by e-books, internet access and mobile group learning, together facilitate rich learning experiences for students. Warren (2009) predicted that the future of e-books would be in more interactive formats that would include hyperlinks and multimedia assets; he also claimed that the authors of e-books would be likely to "explore collaborative models, seeking input on their creative process, allowing others to remix or re-use their work, and teaming up with other authors or fans to create new content" (*op cit*., p.91). Our findings about academics' experiments with e-book creation suggest that this may well be the direction of future developments.

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Unravelling the text book as embodied curriculum: An Actor-Network Theory view of an Android-based eBook implementation in a South African Secondary School

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ABSTRACT
This paper uses ANT to trace the network-effects of two artefacts, an Android Tablet and an eBook as they are released into a newly formed e-learning actor-network (MobiLearn) inside a South African secondary school. Attention is given to the network effects on the identity and role of both tokens and how they in turn influence other actors inside the network. Of special interest is the effect that both tokens have on the understanding of the "book as a container" and the "knowledge is an object" metaphors as they dismantle and destabilize the notion of a text book as embodied, authorised curriculum - despite the fact that this intention is never verbalised by any of the actors inside the network.

Author Keywords
Android, Tablets, Actor-Network Theory, Mobile Learning, curriculum

INTRODUCTION
In January 2012, a high school in the East of Pretoria, South Africa issued all of their Grade 10 learners with Android Tablets. In doing so they became one of the first schools in the country to replace *traditional printed* learner text books with *interactive digital* (Tablet-based) text books aligned to the local curriculum. From the outset, the school administration was clear that if the pilot project (named "MobiLearn") proved successful, it would become the cornerstone of a process envisaged to transform the entire school from a "traditional 'chalk-and-talk' school" to a "digital school" by 2013. As early as the last week of May 2012, the MobiLearn project was deemed such a success that the decision was taken to start planning for "MobiLearn 2013 and beyond". As a result, a meeting with the most important stakeholders was set up by the administrative head of the school to discuss teething issues experienced during the first five months of the project. The meeting also addressed the financial and other implications of expanding the project to the rest of the school and to its full potential.
The mention of "teething issues" is deliberate because the fact that the MobiLearn project was deemed a success by both the school administrator, academic head, IT manager, educators and learners so early in the process (barely four months into the academic year), should by no means be taken as an indication that the pilot was without compromises, persuasions, resistances and coercions. Indeed it was (and still is, at the time of writing) messy and fluid while challenging established networks, processes, procedures and habits - as could be expected with the introduction of a brand new, fairly revolutionary technology into a well established, well-functioning and efficient local school ecosystem.
The aim of this paper is to use insights from Actor-Network Theory to follow the Android Tablet and the MobiReader (eBook) application as "tokens" through the "messy and fluid" implementation of the project. This documents the extent to which both were/are transformed by the emergent assemblage(s) while they in turn play crucial roles in destabilising some established networks and effecting the emergent-but-not-yet-stable MobiLearn network environment.
The most significant of these is how the implementation of MobiReader and the eBook destabilizes the local-global actor-network with its notion of nationally approved "text books" based on an authorised and endorsed curriculum in favour of a much more open-ended eBook as gateway to interactive, collaborative and participatory learning events.

ACTOR-NETWORK THEORY AND INNOVATION IN EDUCATION
ANT, or Actor-Network Theory is an umbrella term used to refer to a field of enquiry into technology, innovation,

scientific discovery - almost any network effect or system involving humans and non-human entities - on the premise that there is a symmetry between the way that human and non-human actors in a network are transformed and in turn translate interests inside a network. Law, while not comfortable with a meta-narrative of what ANT is (Law, 2006) nevertheless provides an eloquent description of what it entails elsewhere: “Actor-Network theory is a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located” (Law, 2006).

ANT originated in the work of Callon (Callon, 1986b, 1986a) Latour (Latour, 1993, 2001) and Law (Law, 2006). It “tries to trace and explain the processes whereby stable networks of aligned interests are created and maintained”(Rhodes, 2009) and concerns itself with describing heterogeneous networks and the relations that hold these together. Crucial to an ANT understanding of the world is that no a-priori hierarchical distinction is made between humans and non-humans (animals and inanimate objects) within a network – especially not in terms of agency. In other words, all objects within a network, human and non-human are treated equally in writing up the “narrative” of a network in a sociology of associations (Latour, 2005, pp. 63–86)159ff).

All objects within a network are seen as actors each with agency and the ability to influence and determine the stability or instability, success or failure of the actor-network (Callon, 1986b, 1986a). In order to describe the interactions and relationships within a stable or failed (attempted) actor-network, Callon developed the notion of translation which involves four moments; Problematisation, Interessement, Enrolment and Mobilisation (Callon, 1986b) and also (Latour, 1993). “These moments constitute the different phases of a general process called translation, during which the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited” (Callon , 1986a, 203).

All actors in a network are defined as part of their interactions with other actors in the network and become strong only by virtue of forming alliances. "Eventually these dynamic attempts by actors to translate one another can appear to become stabilized: the network can settle into a stable process or object that maintains itself. Like a black box, it appears naturalized, purified, immutable and inevitable, while concealing all the negotiations that brought it into existence" (Fenwick & Edwards, 2012, p. 10).

Although Callon's notion of translation as four moments became somewhat programmatic in early ANT studies, this was later recognised by ANT practitioners and addressed in the material semiotics of Law (Law, 2006) and Law and Hassard (1999) among others, partly because of a recognition that reality is often "fluid", "messy" and unpredictable. It is simply not always possible to follow these neat categorisations in the description of an actor-network or of a token as it translates through a network (cf. the relation between the MobiReader application and eBook below). "As a philosophical and theoretical approach more recent ANT studies recognise and validate this picture of the mess, fluidity, contingency and vitality of everyday social practice, and offer resources to explore pathways through it to uncover the workings of power" (Hamilton, 2012, p. 42). ANT draws on Foucault’s notions of the performative nature of power in micro-interactions and shares his interest in excavating how social projects build and become sedimented and institutionalised within everyday practice. "The ANT approach, therefore, offers not so much an explanatory theory, but methods for understanding “messy practices” from empirically grounded cases, and providing descriptions, and “telling interesting stories about, and interfering in, those relations” (Law, 2009). ANT is a radical break from the implicit dualism of approaches in which technologies are viewed as separate from their interpretations of them. Latour (2005) opposes an ontological separation between materiality and meaning, and is concerned not with what objects and texts mean but what they do."

One could argue that initially the tablet and MobiReader enter the project as black boxes, since their roles have been pre-defined quite clearly early on in the project and their roles stabilized by the alliances with the school administration, the service provider, the publisher and the Virtual Learning Environment (VLE). The Tablet will become the replacement of the physical text books, while the MobiReader (eBook) application will become the means by which the curriculum become accessible to the learner. However, as soon as the project starts, and the MobiLearn network is brought to life so to speak, it becomes quite obvious that neither of these are stable objects with clearly defined roles. As the emerging MobiLearn network interactions force new, powerful connections onto both tokens which weaken the initial ties and associations with which they entered the new actor-network their black box status is challenged.

In the past decade or so, Actor-Network theory has become increasingly popular in IS research - often related to case studies of ICT implementations (Law, 2006). However ANT has not quite gained the same traction in education innovation studies as noted by Fenwick and Edwards: "With a few limited exceptions, however, educational research in the main has not demonstrated a similar enthusiasm in the uptake of ANT." (Fenwick & Edwards, 2012, Intr.).

This paper shares the views of Fenwick and Edwards (2012) that "ANT offers truly important insights about the processes and objects of education" especially with regard to the value it brings to a discussion and evaluation of education case studies that involve new technologies.

The Tablet as token

In ANT the notion of a token is closely aligned to the concept of translation and it differs substantially from the conventional idea of an object diffusing through society. While it has some commonality with conventional diffusion studies in that it signifies a brand new innovation being deployed or adopted into an existing, fixed and fairly stable environment, a token in ANT is not, by definition, viewed as a stable entity (Latour, 1993). As Gaskell and Hepburn (1988, 66) point out, in a diffusion approach a discovery or invention moves through society unchanged as it encounters people who use it or resist it. However, "...the concept of translation provides us with an alternative way of understanding these movements across space and time. Here a token is usually not passed unchanged, but can be ignored or taken up and translated as different interests are invested in it. As a result, the token itself is changed" (Edwards, 2012, 28).

The token engages with other entities inside a network of associations and resistances as part of a process through which both the network and token co-evolve. Only once the token stabilises is it regarded as an artefact and will it become "black-boxed" - but only for as long it remains inside a stable network of associations. "Eventually these dynamic attempts by actors to translate one another can appear to become stabilized. ... Like a black box, it appears naturalized, purified, immutable and inevitable, while concealing all the negotiations that brought it into existence" (Fenwick and Edwards, 2012, Intr.).

When we consider the Android Tablet as a token from an ANT perspective in its relations to other entities in the MobiLearn network it initially manifests as just another "tablet device". When it is introduced during the pre-pilot phase as part of the negotiations between the school and the service provider, it is a mobile telecommunications device that will be required to connect to a data-network, deliver data packages to a VLE, afford the rendering of eBooks, run applications, and provide sufficient battery life to comfortably last a school day with "normal" usage and "be durable" throughout the whole process.

But as soon as the MobiLearn project is launched the tablet as token changes. It is no longer a generic telecommunications device manufactured somewhere in China and sold locally as a tablet. Instead, it becomes an object of desire and prestige (the 21st century replacement for traditional textbooks, the differentiator between the Grade 10 learners and the rest of the school, and also between the school and its neighbouring schools), an object of envy. This elevated position is not only a local network effect, but translates itself into a global effect; first when newspapers report on the project while focusing on the *tablets* as text book replacements and then the most popular South African family magazine (You, 20 March, 2012) with a circulation of about 350000 writes an article on *tablets* and learning and features the school prominently. As a direct result of the publicity given to the *tablet* the local school gets translated into a focal point in a global network of Southern African schools, resulting in site visits, consultations and enquiries from schools as far as Namibia. The *tablet* as token becomes more than a physical object - as a result of its associations it becomes a reference point for a discourse about what it means to engage in 21st century learning. The tablet as token is redefined by the network through its local and global links.

Inside the local MobiLearn network, the Android Tablet as a token negotiates a somewhat different path as it engages the physical WIFI network, the educators and the learners. It completely destabilizes the school WIFI network which has been in operation for a number of years, and which had been upgraded before the start of the project. This happens when the WIFI network initially translates the tablet's "anytime-anywhere mobility" to a "sometimes-someplaces mobility" because the signal is not pervasive enough and the network setup limits learners' and educators' movements when they are connected.

However, the tablets are "anytime-anywhere devices" by nature and so they resist this restriction and in alliance with educators, learners and administrators the recently revamped WIFI network is destabilized to such an extent that it is replaced once again, this time allowing for pervasive connectivity. This is an example of why ANT insists on a symmetry between objects in a network (Latour, 2001).

As the Android Tablet is taken up by educators its path through the MobiLearn network is adjusted once again. Although it contains the MobiReader application with the electronic text books (which we will return to later) it manifests itself as a kind of a gateway to the world and in doing so changes the way in which educators think about their teaching and what happens in class. It is no longer a closed-off event happening inside four walls. In the words of one educator "it puts the world at our fingertips". The interaction between the token and the other actors in the network leads educators to "see new possibilities with the token" (Gaskell & Hepburn, 1998, p. 66). After the fact, this network effect seems almost too obvious to even mention, yet it had to first take place before educators came to the realisation of what had actually happened when they were asked to reflect on it. As will become clear in the following section, this gateway effect plays a significant role in the destabilization that happens to the "text book" through MobiLearn and the eBook(s).

Perhaps the most interesting network effect the Android Tablet as token is involved in relates to the learners; where it came to replace their traditional school bag with printed books. As was to be expected, learners accepted this change with open arms - not only did they no longer have to carry around heavy school bags, but the devices are "cool" and allow them to play games and socialise online to their hearts' content (outside of class). But apart from the pleasure learners derive from the tablet, the most interesting aspect is the feeling of being empowered. This is significant because empowerment is not necessarily ingrained in a traditional "chalk-and-talk" model of learning which tends to be hierarchical. As the tablet affords a shift in power within the MobiLearn network, it facilitates a renegotiation in the actor-network constituted by the technology, curriculum, educators and learners. The network and the token co-evolve

(Latour, 2001).

Finally, although it is perhaps too early to tell how the MobiLearn actor-network will stabilize around the curriculum and what constitutes knowledge and learning, it does seem as if the Android Tablet as token in the MobiLearn network is making its most significant contribution in the dismantling of the "knowledge as object" and the "book as a container" metaphors. This may sound like a contradiction since the tablets contain the canonised (CAPS) curriculum as prescribed by the Department of Education after all and which, apart from the interactive nature of the eBooks is not much different than the printed text books. Yet from the picture that emerges as we trace the token in its engagements with the educators and learners, it is obvious that boundaries are being eroded: The classroom is expanded beyond the walls to cover "the world" and with it the idea of knowledge as object in favour of learning as an event.

"This contrasts with a classroom only containing textbooks, blackboards, pencils, notebooks and chalk, which over the centuries has become a stable practice with well-established and well functioning ties to the producers of the artefacts used for teaching and learning. If the chalk breaks in two or a book is in bad condition there are well-known practices for fixing these breakdowns in the normal flow of activity, practices where teachers and learners exert a great deal of agency" (Arnseth, 2011, p. 359).

Simultaneously, books are no longer seen as closed, container-like entities that encompass all necessary knowledge or facts. Empowered learners now have the opportunity to change from passive receivers of knowledge to active learning subjects because the Android Tablet as token inside the MobiLearn network has started to erode the established hierarchical roles of "teacher" and "pupil" and "closed" book. This is similar to what Nespor (2012, 1) refers to when he says that: "... devices can be used to reorganize agency itself... shifting the location or attribution of who does what, shifting participants from one actor category to another, or creating new categories of agents." To what extent this redefinition of the actor roles of educator and learner will eventually stabilize is still unclear and it is certain that the entrenched power inherent in the commonsense understanding of "knowledge as object" and the curriculum as "authority" as well as the classic teacher-pupil framework will resist these changes. The final outcome will most definitely be a result of new alliances within the school actor-network where agents such as the Android Tablet, VLE, MobiReader, learners and educators alike will play a role as the MobiLearn assemblage evolves. As (Harmon, 2007) remarks "entities are not just effects of their interactions with others, but are also always acting on others, subjugating others and making things possible."

MobiReader (eBook) as token

In what follows the MobiReader application and the eBook(s) which it renders/delivers are deliberately treated together simply because neither can exist meaningfully without the other (inside the MobiLearn network). Also, the term eBook is used to designate a class or type of object/token rather than a subject book.

The eBook as token enters the MobiLearn network when it is made available via the MobiReader application that was developed specifically to render interactive multimedia content from inside the EPUB format. It represents the digital version of the "approved"/aligned properly printed" hard copy text books which carry the authority of the Department of Education and the approval of the school administration - powerful allies indeed.

Yet, despite these credentials, it does not remain black boxed. In fact, because of its close ties with the MobiReader application its alignment with the "book as container" metaphor is almost immediately challenged. The same goes for its status as a canonized version of the curriculum put together by experts and endorsed by experts with the authority to do so. This happens because the MobiReader application is much more than simply an eBook rendering tool. It is at an important nexus between various powerful actors in the MobiLearn network. So in its own alignment with the VLE, the service provider, educators and learners, it is put in service of facilitating social constructivist *learning* rather than merely providing access to *knowledge*. As it is introduced into the MobiLearn network, its alliances force it to become a communication tool, a note taking tool and collaboration platform. But most importantly, however, it becomes a vehicle through which educators can add content to the prescribed, authorised and approved curriculum-based content.

In this process, the notion of an approved curriculum based text book is turned on its head. Educators will be able to add to what has been "canonised" depending on their own understanding of the curriculum or the needs of the learners and/or within the MobiLearn actor-network - even though this was never the *intention* of any of the actors within the network. There is no campaign to discredit or undermine the curriculum. It is simply taking place as a result of the network effect of the MobiReader (eBook) as token.

The MobiReader/eBook as token is a great example of how the closed-ness and authoritarianism of a traditional hierarchical education system will become increasingly challenged as digital learning gains traction in the 21st century, not necessarily because of a campaign against it, but perhaps even more so as a result of the inherent nature of the digital artefacts that will be used to assemble digital learning.

CONCLUSION

Using ANT to trace how two tokens through the MobiLearn actor-network that was established when Android Tablets replaced traditional text books at a secondary high school in South Africa enables one to become aware of network effects that may otherwise have remained hidden. Especially useful was how an ANT analysis of the Android Tablet and MobiReader application (eBooks) confirmed that no technology is value neutral, and that once introduced into an existing network it may lead to unexpected consequences. In the case study we examined, there was an existing network around approved, curriculum-based text books that involved both a local and global component, and which was apparently under no threat from either educators or learners. Yet, with the introduction of the tablets, MobiReader and eBook(s) an existing paradigm of authority and hierarchy is suddenly being dismantled and destabilized. What is even more interesting from a research perspective is the fact that neither the educators, nor the learners (and probably most other actors in the MobiLearn network) do not realise that they are in the midst of a mini (local) education revolution that goes far beyond the ability to collaborate or add notes to an electronic text book. This ties in with the ANT notion that network effects do not necessarily happen because of a specific intentionality.

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Industry Showcase

Thuze: The Interactive Mobile Learning Solution

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Type	x Workshop	☐ Tutorial
Duration	x Half-day event	☐ Full-day event

Rationale (to be published on the mLearn web-site)

Thuze (www.thuzelearning.com) is a cloud-based learning platform that delivers advanced classroom content to its users. At the core of Thuze's effectiveness is its peer-driven etextbook experience, which underwrites the success of mobile and contextual elearning with classroom interaction. Buttressed by its comprehensive content package – including traditional text, audio, and video as well as self-assessment diagnostic tools – Thuze delivers students a complete learning experience, across a variety of devices, including the iPad, Android, Kindle, desktops and laptops.

Providing this comprehensive mobile learning experience to modern students has been a prime motivator behind Bridgepoint Education's development of mobile learning technology. The parent company of Ashford University and University of the Rockies, Bridgepoint has fostered an aggressive program of innovation and improvement of classroom connectivity, content and participation for all its learners and faculty. It is in this atmosphere that Thuze has taken shape. With the introduction of its innovative digital learning platform to Ashford's students and instructors (under the name Constellation), Bridgepoint provided Ashford students and faculty with full-spectrum content (including video, audio and lectures), collaborative notes, cross-platform flexibility and a fully supported online discussion environment (www.ashford.edu/student_services/constellation.htm). Constellation, which was recognized in the 2011 Horizon Report as "Technology to Watch", and a CODiE Award finalist in 2011) was the progenitor of Thuze. Constellation's interactivity, comprehensive content and the accessibility of its platform were designed specifically to meet the needs of Ashford University, and provided the essential starting point to develop and deliver Thuze as a mobile content platform for schools and universities worldwide.

The Thuze platform's mobile etextbooks are available to students via the iPad, Kindle and other tablet devices. Its functionality is designed to make the learning experience equally valuable through these mobile interfaces, delivering students and faculty the same cloud-based notes, classroom interaction, personalized quizzes and study guides of desktop and laptop users. In addition to the features available to all Thuze users, mobile access to Thuze gives tablet users a tactile interface unavailable on a desktop, providing full-spectrum fingertip interaction. Thuze's cross-platform multi-device flexibility provides students and instructors access to their learning content and to classmates from any device, at any time. Thuze in context:

Cloud-Based Mobility: The crown jewel of the online classroom experience: Thuze makes its suite of cross-platform learning tools modular, flexible and mobile, from desktop to laptop, iPad to Kindle.

Collaborative Learning: Networked comments, notes and highlighting render inter-student dialogue and concept development accessible and comprehensive. Social commenting and peer-dialogue constructs support this feature.

Multimedia: Extensive use of dynamic content, including embedded video, audio, interactive timelines, PowerPoints and on-screen lectures.

Quizzes and built-in analytics: Pre and post-chapter self-assessment and diagnostics, personalized learning plans, organized notes and highlighting for custom study guides,

Format

Thuze's effectiveness is based on several core successes: availability, flexibility and quality of content. In a workshop featuring the best and brightest of the design, editing and creative teams behind the Thuze platform, mobile and contextual learning professionals at MLearn Helsinki will learn about the process of bringing this innovative etextbook platform to life. We will reach out to its audience, walking attendees through the initial concept, the creation of platform and content, the pitfalls of the project and what the editorial and development teams learned in the process, including feedback from surveys and focus groups of Ashford and client students and faculty. We will also include a hands-on demonstration of the interface environment powering Thuze and the platform that started it all, Constellation.

Presenters

Co-Presenter: Peter Galuardi, Director of Editorial Technology, joined Bridgepoint Education in August, 2009 to assist the product development effort for Constellation, which later evolved into Thuze. Mr. Galuardi is responsible for assisting in the development and implementation of strategic publishing plans for instructional and learning products; and for the acquisition and development of associated media products for private label initiative. Before joining Bridgepoint Education, Mr. Galuardi spent nearly 10 years in the college textbook publishing and software industry and worked for publishing houses: McGraw-Hill Higher Education, Cengage Learning, and Houghton Mifflin Co. in various editorial roles. Mr. Galuardi earned his Bachelor of Science degree in Mathematics from the University of Massachusetts.

Co-Presenter: Mireille Yanow is a Sponsoring Editor with Bridgepoint Education. She leads an editorial team focused on content development for Constellation. Prior to joining Bridgepoint Education, Ms. Yanow served as a Managing Editor at Macmillan Education in Oxford where she spearheaded the publication of English language textbooks for the international market. She previously served as a Publishing Editor at Elsevier Science and also spent six years teaching English. Ms. Yanow has lead interactive panel discussions and presentations at various educational conferences. She received her Bachelor of Science in Geology from Queens College, C.U.N.Y and her post-graduate certificate in teaching English from John Jay College, C.U.N.Y.

Organisational requirements

Internet access, Projector, we will bring our own laptops.

Target audience

Professors, Academia, practitioners, government – any industry that would use etextbooks and an etextbook platform

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Mobile access to scientific event information: An Android tablet application for ginkgo

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ABSTRACT
Researchers use an increasing number of social media tools and adopt practices of the Web 2.0. In the so-called Research 2.0, researchers are increasingly overwhelmed with the amount of available data and need to make educated decisions based on an analysis of the condensed information. Our previous research on awareness support for researchers led to the development of ginkgo, a social scientific event management system that combines classic features of conference management systems with features that are now well-known from many social networking applications. In this paper we report on the development of an Android tablet application for ginkgo that is driven by the researchers' requests for a more aggregated and easy-to-use, context-aware interface to the information in our system.

Author Keywords
research networks, research 2.0, API, conference management system, social interaction, social software, android, REST, mobile conference application, awareness support

INTRODUCTION
The adoption of Web 2.0 tools, technologies and practices in the context of research work is often labeled as Research 2.0, Science 2.0 or e-Science (Waldrop, 2008; Shneiderman, 2008). The application of Web 2.0 on research led (and still leads) to an increasing amount of published scientific content in conferences, journals as well as blog posts, wiki entries and tweets on early research results and comments to those outputs (cf. Rowlands and Nicholas (2005); Renear and Palmer (2009); Priem and Hemminger (2010). Priem and Hemminger (2010) point out that often too much work is being published which hinders the work of tenure and promotion committees. Renear and Palmer (2009) found out that today's researchers read 50% more papers than their 1970s fellows while spending less time on each single paper. Research is conducted in an increasingly networked manner and due to an ever-expanding amount of information created it is getting harder to filter the stream for relevant information. Recommender systems are one solution to overcome this. On the other hand, an increasing number of researchers are evermore relying on the power of their social network and active engagement in social relations to stay aware of relevant information. Thus, awareness support for researchers has both a technical and a social aspect: automatic recommender systems can make predictions of which content I might be interested in, based on the history of my own actions and the interactions with others while peers might send interesting links and objects because they know my area of interest.

The same issues exist in the context of scientific events: often researchers get to know of relevant call for papers briefly before or even after the deadline because they had no socio-technical support that would have alerted them earlier about the relevant event. In Reinhardt et al. (2011a) we have introduced the ginkgo system as one approach to make use of the very rich information that can be derived from the interactions with a conference management system and combine those information with the social power of social networking sites. In this paper we describe the derivation of requirements on a mobile application to support researchers' awareness in scientific events. Therefore, we investigate some existing mobile applications that target attendees of scientific events and list their strengths and weaknesses. From the requirements on the mobile application, we describe the development of a REST-based API for the ginkgo system (Reinhardt et al., 2011a) in order to provide data access on the mobile. Moreover, we describe the design and implementation of the ginkgo mobile tablet application for Android.

SOCIAL SCIENTIFIC EVENT MANAGEMENT WITH GINKGO
In Reinhardt et al. (2011a), we introduced *ginkgo* as a social scientific event management system that combines classic features of conference management systems (CMSs) with those known from well-known social networking sites like Facebook or Twitter. Ginkgo has been designed and developed as a novel approach to the organization and participation

in scientific events against the background of our previous studies on awareness support for researchers (Reinhardt, 2012; Reinhardt et al., 2012). The organization of scientific events is a very prestigious task that is accompanied by several tasks that have to be conducted before, during and after the event. Based on a literature study, we could identify a generic phase model of the organization of scientific events in which both organizers and attendees of the events are in need of technological support in order to fulfill their tasks (see Reinhardt et al., 2011a). The identified phases are 1) the *preparation phase* in which basic decisions regarding the name, focus, time period of the event have to be made and the call for papers has to be prepared and spread, 2) the *submission phase* in which interested authors can submit their manuscripts or other kind of contributions to the event, 3) the *review phase* in which the submissions have to be assigned to and reviewed by knowledgeable reviewers. These reviewers should not be biased towards the submission under review in order to produce an objective evaluation of the submission. In phase 4) the *selection phase*, the program committee has to select the submissions that will be selected for presentation at the event. In phase 5) the session planning phase, the overall schedule for the event will be planned. Typically the schedule has multiple streams and the accepted talks are assigned to one of those streams. The program committee has to consider time and room capacity constraints and to continuously update the session planning because of change requests by the presenters and organizers. The actual *event* is phase 6 of our generic phase model and followed by phase 7) the *post-processing* or *community awareness phase*.

The persons involved in the above-described phases possess different roles and interact with a wide range of other persons with same or different roles. The social interactions that take place in the context of scientific events are manifold but yet poorly supported by existing CMSs. Thus, many researchers rely on external social networking services like Facebook, Twitter or Crowdvine[1] to enhance the social experience during the whole timespan of the event (see Reinhardt et al., 2011a). In ginkgo, we support social interactions between organizers and potential attendees of an event through different means: researchers can start following each other in order to stay aware of the latest news from the other; they can engage in private chats and mark each other in their status updates. The same is possible for scientific events: researchers can simply follow an event in order to stay up-to-date about the latest news and changes and they can more particular indicate that they plan to attend the event which severs as indicator for others that they might be able to see the researcher at the respective event. If a researcher agrees to act as co-organizer or member of the program committee of an event, their activity stream will be updated accordingly, serving as a trigger for interaction with their friend and followers that might be interested in more detailed information about the event.

Since its debut, ginkgo has been used in a number of small scientific events (see http://ginkgo.cs.upb.de/events), which allowed us to evaluate the tool as such and to improve some of its functionality. The tests also show the potential of ginkgo together with indications for future enhancements of the tool. One reoccurring theme is that attendees of scientific events wish for location-aware mobile applications that interface with ginkgo and that they could use during the event in order to stay up-to-date of relevant information (Reinhardt, 2012; Reinhardt et al., 2011b). In the following section we review and compare three mobile applications that have been explicitly developed for the context of scientific events and point out their strengths and weaknesses. From this analysis we derived some feature requirements for a mobile application for ginkgo.

MOBILE APPLICATIONS FOR SCIENTIFIC EVENTS

In order to get the information given by a Conference Management System during an event the participant needs a mobile device and an Internet connection. This data can either be shown inside a browser or through a native application for the mobile operating system, which provides a better experience. In the following, we give an overview of existing mobile CMSs Apps and their features and points out why none of them satisfies all needs of participants.

As a participant I want to stay in contact with others and be informed about events. So the features can be divided into two major groups, namely Social Networking and Event Awareness. Social Networking contains features like getting information about each user by accessing their personal profile and contact them via personal messages or every follower by posting a status update. Event Awareness consists of being informed before, during and after an event took place. A user usually wants to browse through multiple events and their topics to decide if they are interesting for him. During an event he wants to stay informed about any changes and the presentations he would like to visit. In case of the user's wish to gather more information about speeches he should have the possibility to read the related papers and rate them.

Contrasting juxtaposition of applications

The *I-KNOW Conference Assistant*[2] was written exclusively for the i-Know 2011 conference[3] and is available for both iOS and Android smartphones (see Figures 1 and 2). The application provides detailed information about the conference sessions and talks but it obviously does not contain any information about other events. Since the application lacks a personalization feature, the supported social networking features are also very minimalistic and can only be realized

[1] http://crowdvine.com/

[2] http://itunes.apple.com/app/i-know-conference-assistant/id387869871?mt=8

[3] http://i-know.tugraz.at/

using external applications. The I-Know Conference Assistant features a well designed and seamlessly integrated note-taking feature that allows saving notes for each talk and that can be synced to a desktop application. Moreover, the application contributes to the fact that an increasing number of researchers use Twitter in the context of scientific events by assigning a dedicated hashtag to each and any talk in the overall schedule. Finally, the application contains a map view that shows the locations of all relevant event-related places and thus may help the user to find its way to the conference dinner or the main conference hall.

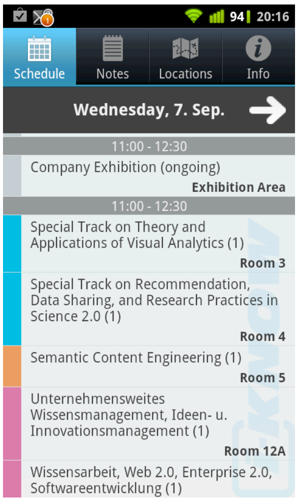

Figure 1 Schedule view in the I-KNOW Conference Navigator

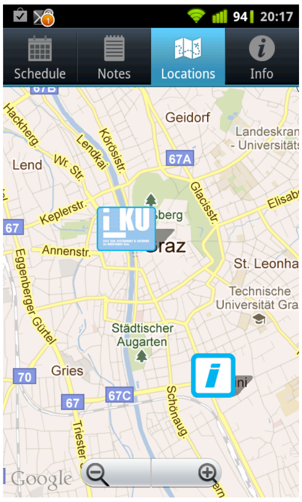

Figure 2 Map view in the I-KNOW Conference Navigator

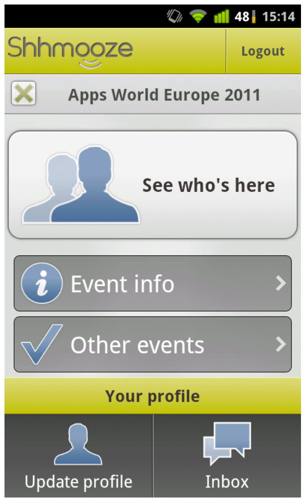

Figure 3 Event overview in Shhmooze

A different approach is used in *Shhmooze*[4]. Each user needs a personal account to use the provided services like browsing through registered events and seeing who attends (see Figure 3). In order to communicate with others and to see who is visiting the specific conference, the users have to be checked in at the same event. Thus, Shhmooze does not provide potential attendees of the event with an easy-to-use overview of who plans to be attending the event. Moreover, since there is no "friend functionality" provided by Shhmooze, there is no way to stay in contact with other researchers after having met at an event. In order to do so, the researchers have to rely on traditional means of communication. However, the application provides a function to register new events along with some basic information like date, location and topic. The information is sent to Shhmooze's back office via email and processed there. Detailed information about sessions and talks at the event cannot be included.

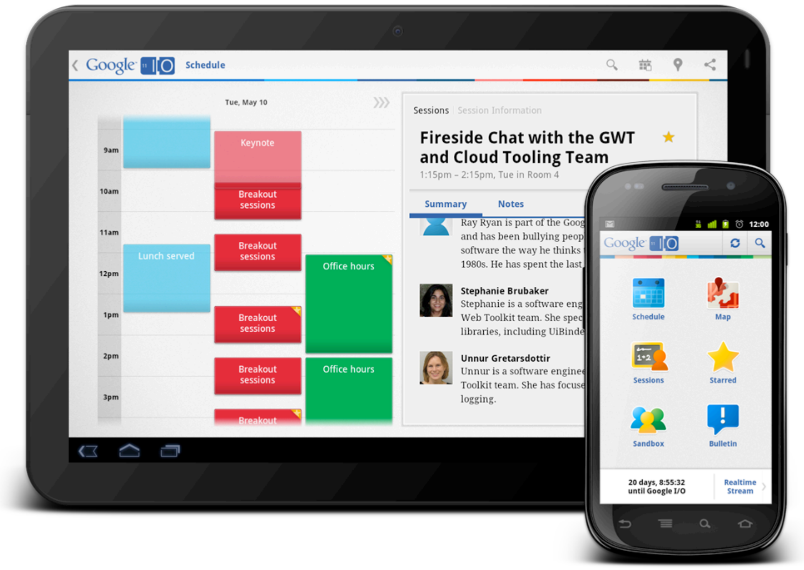

Figure 4 Google's iosched on a tablet and smartphone

The third application that we investigated is Google's *iosched*[5] application that has been developed exclusively for the Google I/O developer conference. iosched offers a well-designed and easy-to-use overview of every session and the talks

[4] http://itunes.apple.com/app/shhmooze/id400523342?mt=8

[5] http://code.google.com/p/iosched/

in each of them. The application features a unique map application that shows which session takes place on which floor and in which room of the conference building. Moreover, it integrates a social media stream as a central element of the main interface. Finally, the application lacks a social network layer, which presumably will be added to an updated version for the 2012 I/O conference. The complete code of the application has been made publicly available by Google and can be used for own projects.

Recapitulatory comparison

After having investigated the above three mobile applications for scientific conferences, we have to conclude that so far there is no application that combines a detailed access to the information about the conference and a social network to further support information diffusion between researchers. Moreover, two of the applications are built for one dedicated conference only and thus cannot be used for multiple events at all. The three applications also have strengths that we do not want to gloss over such as the check-in feature of Shhmooze, the great note-taking feature and the dedicated Twitter hashtags of the I-KNOW Conference Assistant or the indoor maps and the beautifully designed schedule of Google's iosched. Table 1 provides a side-by-side comparison of the three applications with the developed gingko mobile.

	Shhmooze	I-KNOW CA	iosched	ginkgo mobile
System Features				
Support of multiple events	✔	✖	✖	✔
Express interest in an event	✔	✖	✖	✔
Browse through registered events	✔	✖	✖	✔
See where events take place on a world map	✖	✖	✖	✔
View the event schedule	✖	✔	✔	○
Take notes	✖	✔	✖	○
Social network features				
Create a user profile	✔	✖	✖	✔
Write status updates	✖	✖	✖	✔
Read activity streams	✖	✖	✖	✔
Write private messages	✔	✖	✖	✔
Add friends	✖	✖	✖	✔
Browse through followers	✖	✖	✖	✔
Event management features				
Create an event	✔	✖	✖	✖
Create reviews	✖	✖	✖	✔
Create an individual schedule	✖	✖	✖	✔
Download papers for talks	✖	✖	✖	○
✔ = feature is available ✖ = feature is not available ○ = feature is in preparation				

Table 1. Comparison between mobile CMSs applications.

Requirements for ginkgo mobile

From the analysis of the above mobile applications and in line with the features of the ginkgo web application (see Reinhardt et al, 2011a), we defined the following requirements for the first version of ginkgo mobile. First, users have to be able to login to the application. Since the web application allows to login via Twitter or using username and password, the same should be possible on the mobile application. Users should be able to access user and event profiles in order to browse through the respective activity stream, to follow other users and indicate their interest in scientific events by following them or indicating their plan to attend the event. When a user comes to the event venue, he should be enabled to check-in at the event, so that the other researches are informed about his arrival. The check-in feature is a direct enabler of social interactions amongst event attendees. Moreover, users of ginkgo mobile should be able to send private messages with other users to support their social interactions. Since social media coverage of scientific events has become commonplace today, users of ginkgo mobile should be enabled to send status updates and directly forward them to Twitter. Finally, we choose to not enable users to create new events directly on the mobile application; the process requires much structured information such as the call for papers, deadlines and the invitation of co-organizers and reviewers, which is not easily to support in a tablet application.

DEVELOPING AN API FOR GINKGO

In order to realize the native mobile application described above and to enable an easy integration and propagation of data, it is essential to offer access to the ginkgo core system via an Application Programming Interface (API). An API is advantageous for both parties: API consumers and API providers. On the one hand API consumers get the possibility to process data independently of the provider's user interface whereas on the other hand the API provider gains popularity and traffic.

Choosing an appropriate architecture

There are several possibilities and styles to develop a web API. According to one of the biggest directories for Web 2.0 APIs (ProgrammableWeb, 2012) the architectural style that is used the most often for Web based services is Representational State Transfer (REST) (Fielding, 2000). ProgrammableWeb (2012) contains around 6.000 APIs whereof 70% use REST and 21% use SOAP.

REST became a de facto standard for web APIs because it simplifies processing heterogeneous data from different sources in a homogenous way. Every piece of information a REST API publishes is modeled as a resource, must be uniquely identified with a Uniform Resource Locator (URL) and supports the same set of operations (the Hypertext Transfer Protocol (HTTP) methods). These principles have a far-reaching effect on interoperability and data exchange (Battle & Benson, 2008). For example, on a video portal a video is not *commented* (verb) but rather a comment is *created* (noun). Because a comment is modeled as a resource (differently to SOAP, for example, where this would be an action) it is possible to reuse it in a completely different context. Thereby API consumers can choose the representation format, which fits best to their requirements (e.g., JSON, XML or HTML). Figure 5 schematically compares common interfaces with REST interfaces.

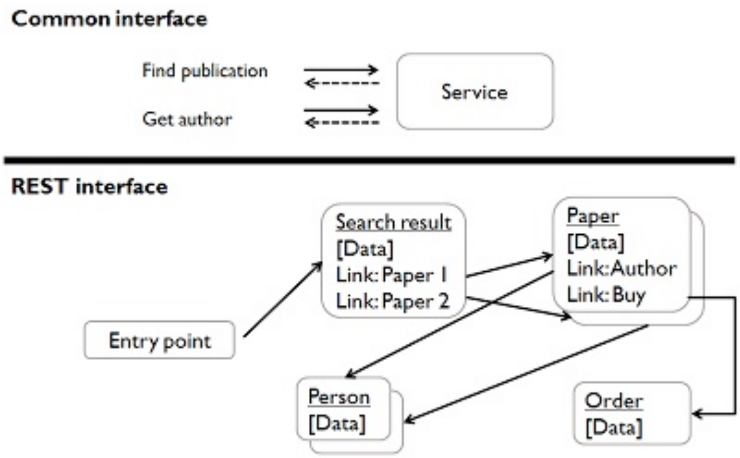

Figure 5 Comparison of common and REST interfaces

A common interface offers access to data via several functions ("Find publication", "Get author"). Communication with a REST interface always starts by retrieving the representation of the entry point resource, which includes *hyperlinks* indicating the next possible actions for the API consumer (comparable with *transitions* in state machines). In Figure 5 we choose to search for a publication and receive the representation of a search result resource, which in turn contains hyperlinks to all of the found papers. With this architecture, exchanging particular pieces of data offered by the interface is simple, as every resource has a fixed URL. Furthermore, the integration of external data in our own service is as simple as referencing this data via a hyperlink in one of our representations. Furthermore, a performance evaluation of RESTful web services and SOAP based web services especially for mobile devices in Hamad, Saad and Abed (2010) reveals advantage of REST over SOAP. As a main result of the evaluation, the message size of RESTful web services is smaller than the size of SOAP messages. Additionally less response time per request leads to less power consumption of mobile devices and a better user experience.

The advantages mentioned above turn REST into the appropriate architectural style to develop an API for ginkgo.

Core concepts of the ginkgo API

As starting point of the API development a data model, source code and the running ginkgo web application are available. To develop the resources and representations needed, we roughly follow the steps Richardson (2007) proposes:

1. Derive resources from relevant parts of the data model of the ginkgo core system.

2. Add additional resources to support all desired functionalities.
3. Name the resources with URLs.
4. Choose the HTTP methods every particular resource should support.
5. Design the representation(s) for every particular resource.
6. Create connections between resources by adding hyperlinks to their representations.

Media type and versioning

The media type (also called mime type) constitutes the basic contract between client and server and defines how they should communicate. The description of a media type must contain the semantics of all elements within a representation, which belongs to this media type. To give a meaning to hyperlinks we use *rel* and *href* attributes like defined in Nottingham (2010):

```
{"rel":  "self", "href": "https://api.ginkgosem.com/users/3jfe" }

  {"rel":  "https://api.ginkgosem.com/rels/collection/comment",
     "href": "https://api.ginkgosem.com/users/3jfe/comment" }
```

The three lines above show two links in JSON syntax. The link relations `self` and `https://api.ginkgosem.com/rels/collection/comment` identify the semantics of the corresponding target resource in the *href* attribute. `self` is globally standardized (see http://www.iana.org/assignments/link-relations) and indicates that the target contains the URL of the resource in the current context. The second link relation is ginkgo-specific, therefore has to be in the form of an URL and indicates that the corresponding link points to a list of comments.

Having implemented these semantics and following the rules HTTP defines, an API consumer navigates via hyperlinks through the API until he reaches the representation of a resource, which includes the desired information.

The ginkgo API uses the media type for versioning, too. Our media type (*application/vnd.ginkgosem-v1+json*) contains a version number, which will be incremented for upcoming new versions. Corresponding to the content negotiation mechanism in HTTP, an API consumer always requests and accordingly receives the version he understands. Versioning through the media type is to be preferred to including a version indicator in the URL of a resource, because a URL identifies a resource, independent of the version of its representation (Masse, 2011).

Security

In terms of API security, attention should be paid to authentication, authorization and request limiting. OAuth 2.0 (Hammer, Recordon & Hardt, 2012) is the emerging method for authentication in the field of web APIs. Using it for the ginkgo API, it enables a registered ginkgo user to access ginkgo via mobile applications or any mashup services without giving his or her credentials to third-party applications. All third-party applications must register with ginkgo once and receive a unique client ID. With this client ID and the accordance of a gingko user a third-party application can request an access token for this particular user from the API. This access token empowers to access the ginkgo API on the user's behalf.

In ginkgo, the client ID and the access token are also used to realize authorization and request limiting. As there is public information in ginkgo like Call for Papers or activity steams of events, there has to be a possibility to access this information without any user authentication. Therefore the ginkgo API allows requests, which only include the client ID for authentication ("public requests"). For every request it is checked if the current resource is not user specific and thus can be retrieved. Additionally a counter is incremented (and reset after an adjustable period of time) for every request from a specific access token and client ID to prevent that any API consumer overloads the API.

DESIGN AND IMPLEMENTATION OF GINKGO MOBILE

After implementing a REST-based API for ginkgo, the system offered all necessary functionality to realize the required features described above. In this section we report on the design and implementation of ginkgo mobile, an Android tablet application that serves as mobile interface to the social features and content available in ginkgo.

Design

ginkgo mobile's user interface follows the one of Google's iosched application (see Figure 6). After a successful login the main screen will be split into two parts. The left side of the screen (number 1 to 7) contains an array of buttons that – following the dashboard design pattern – stay visible and can be used during the whole working with the app. The right side of the screen (number 8 and 9) is a container for the different views that will be shown. Initially, the container includes the personal activity stream (8), which serves as personalized information stream and is composed of news items that individuals and events that the researcher follows have shared. The same area is later used to show user and event profiles, a list of events and follower as well as user and event activity streams. Touching the user profile icon (2) will bring the user to his own profile where he can see statistics about his social connections, post status updates and see his personalized news stream. The messages icon (3) leads the user to an overview of his private chats with other users of the ginkgo tool. By pressing the event button (4), the user is presented a list of events that are organized using ginkgo. For this list he can navigate to the event profile pages where he can start following the event or can indicate that he plans to attend the event. Moreover, the event profile shows information about the call for papers and a news stream for the event. The event profiles are also reachable by pressing the check-in button (6). The main difference is that in this case the user is presented a map view where he can explore events that are close to his current GPS position. The single events are marked with pins on the world map and a researcher can choose to check-in at the selected event or to see the event profile. The followers and friends of the logged-in user can be explored after pressing the button 5. Some selected settings can be changed in the dialog that opens after pressing the settings button (7). Finally, the action bar on the upper area of the interface contains links to the main dashboard (1) and a shortcut to posting status messages (9).

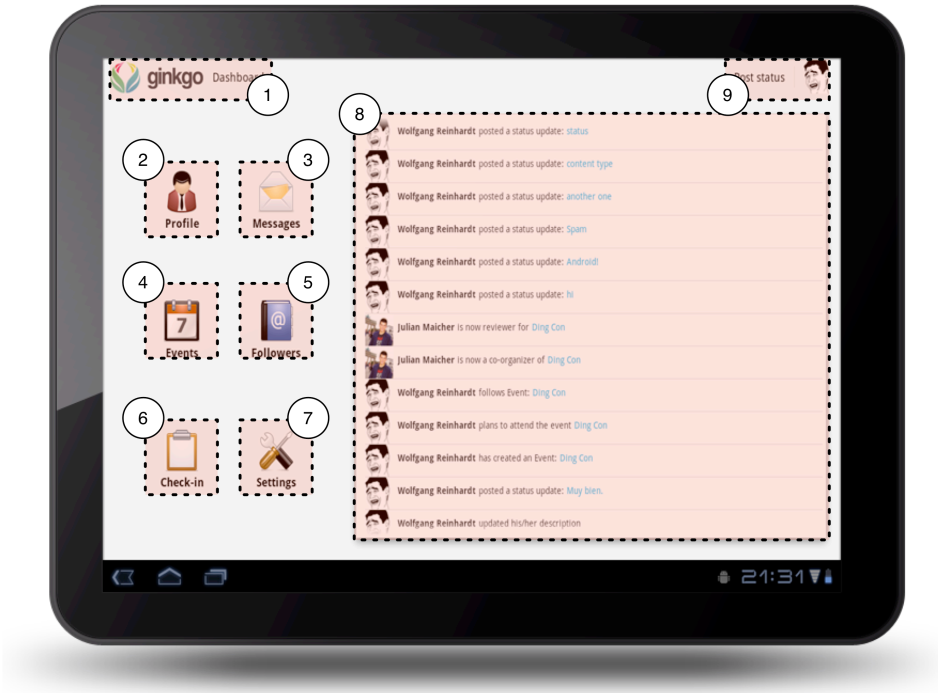

Figure 6 Main elements of the ginkgo mobile interface (on Android 3)

Implementation

ginkgo mobile is currently developed using the Android 3 software development kit (SDK) and thus runs on all the latest Android tablets. During the development of ginkgo mobile, Google released the Android 4 SDK and we plan to port our code base to Android 4 in the near future. Since Google released the source code of iosched as Open Source, we originally planned to reuse large parts of the code for our own implementation. However, during the development process we stumbled upon several oddities of the code that made it harder to reuse the existing code rather than implementing it completely from scratch. We did, however, reuse the interface design of iosched, as it was well designed to have the dashboard like navigation on the left and enough room for exchangeable content on the right.

In Android, different UI states are created using so-called activities that have their own controllers and might have separate layout as well. The navigation through those activities is realized using an activity stack that enables the user to go back and forward in history of screens. The login is handled by a special activity that takes care of the OAuth 2.0 procedure (Hammer, Recordon & Hardt, 2012). Therefore, a web view is started where the user can provide his username and password and the generated access token is stored persistently and securely on the device. Upon successful authentication, the dashboard activity is started. This interface contains two so-called fragments and the action bar. The left fragment contains the navigation buttons as described above; the right fragment is the container for the context-dependent content. The communication with the ginkgo REST API is realized using helper classes that take care of networking and the deserialization of JSON data. The single activities have access to the helper classes and can make use of the provided functions. Moreover, the helper classes implement a quality of service layer in that they make sure HTTP errors are handled and calls to the API are repeated in case they fail.

CONCLUSION AND OUTLOOK

Starting from the far-reaching changes that came with the adoption of Web 2.0 tool, technologies and practices in research, in this paper we have made the case for enhanced management of scientific events. We outlined how adding a social layer to conference management systems may not only enhance awareness of the entailed researchers but also serves as a rich source of information for recommender systems. With ginkgo we introduced our approach for a social scientific event management system that integrates classic conference management systems with well-known features from social networking sites. Our previous research showed that researchers wish for a handier tool for awareness support in the context of scientific events, which should be tailored to mobile use. In this paper we have performed a competitor analysis of three mobile applications for conference attendees' support and could derive requirements for the implementation of a tablet application of ginkgo. Our comparison shows that the three applications under investigation are all lacking the support for social networking of (potential) attendees and are mostly not prepared to support multiple events at the same this.

Based on the requirements of ginkgo mobile we developed a REST API for ginkgo that comes with authorization via OAuth 2.0 and an intelligent versioning concept that makes use of vendor-specific media types. Thus, each API consumer can request the data provided by the API in a version that it understands. This way, the application infrastructure does not break by updating the API to a new version. The ginkgo API provides data in JSON format, which have to be deserialized on the client and thus offers a broad compatibility with most programming languages.

We have described the visual design of ginkgo mobile that is based on Google's iosched application and provided insight to the basic implementation of ginkgo mobile. The application has yet to be evaluated with users from the intended user group. The feedback from this evaluation will be used for improving the overall user experience and usability of the app when we go on and change the code base to the Android 4 SDK. During this transition we plan to make use of the Calendar API, which allows making calendar entries for each talk that a user is interested in. Moreover, we plan to integrate social networking and check-in functionality based on Near Field Communication (NFC) into ginkgo mobile as soon as the first NFC-enabled tablets will we available (see Reinhardt et al. (2011b) for a description of the possibilities of NFC-based communication in scientific events).

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Eedu Elements, a Finnish K-6 school in a mobile game

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ABSTRACT
Education is one of the most important factors in every person's life. Globally it has even more important role, since it is the fundamental source of democracy and it also forms basis for overall humanity and equality. Eedu Elements will implement Finnish Elementary School into mobile applications, which will be available for Apple, Android and Chrome users globally in 2012.

Author Keywords
games, education, learning, school, mathematics

INTRODUCTION

Experienced teachers are aware that when a pupil is asked to teach another pupil, both pupils learn. This fact has not been applied enough in educational games, mostly because of a lack of technology and game AI that enables players to teach conceptually challenging themes still remaining easy-to-use game play.

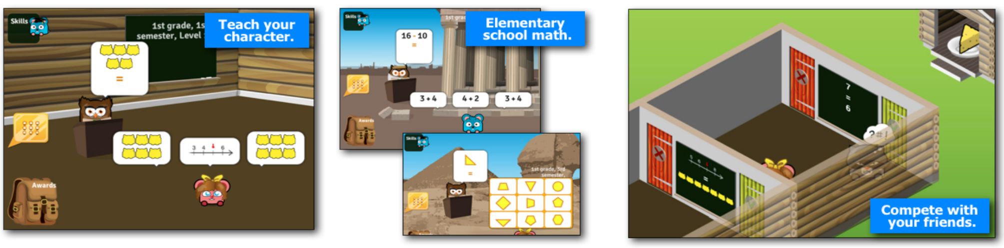
Eedu Elements connects learner into things they can experience on daily basis when teaching skills into their game characters. The game characters learn like humans do: inductively case-by-case by building relations between new and existing concepts. The background of Eedu Elements is in learning-by-doing, learning-by-teaching and to some extent learning-by-programming. The approach is learner centric: the game introduces mathematics in a way that learner can build his/her mental conceptual structures by adding new concepts into known ones.

One of our special focuses has been scientific proof of concept: We have shown educational outcomes as well as motivation towards teaching virtual pets: Under experimental settings, more than 60% of players increases their skills remarkably during the two hours gameplay (Ketamo & Suominen 2010; Kiili, Ketamo & Lainema 2011). The outcome in natural learning environment with possibility to long-term gameplay is even greater: In fact, we have shown that the best outcome is achieved when there are enough informal discussions between game play (Ketamo & Kiili 2010).

The AI technology behind the game is based on authors earlier work (e.g. Ketamo 2009). Each game character is a teachable agent that learns through interactions and evaluations during the gameplay. The most important finding is that performance measured from player's game characters correlates highly with assessment done with traditional paper tests (Ketamo 2009; Ketamo 2011). Finally, we can say that while teaching his/her virtual character, learner reproduces a model about his/her mental conceptual structures. Because of this, we can produce detailed analytics about learning.

KEY FUNCTIONALITY AND GAME PLAY

Since opening its public beta in February 2012, Eedu Elements has gained interest of over 3000 users in more than 100 different countries. The key functionalities (figure 1) are following: i) Player will learn while teaching. ii) Player can use his / her strengths without knowing any language. iii) Cognitive load can be adjusted according to the learning progress.



Characters learn like humans:
- inductively case-by-case
- learner centric: through numbers, visually or relations
- player is responsible for character's mental development

Human-like learning enables human-like analytics:
- player can see his / her competences in seconds

Game characters can compete against any other character any time
- all behavior and skills are always available in online

Figure 1. Eedu elements key functionalities.

Eedu Elements provides scaleability for millions of simultaneous users, but also fast development environment for new learning concepts: HTML5 framework makes game development, distribution and maintenance efficient.

LEARNING- AND ACADEMIC ANALYTICS

In-game learning analytics are meant for parents and teachers to quickly observe what learner has taught for his/her game character. The visualisation (figure 2, left) shows correctly taught concepts in selected level with green bars that are that higher what better learner knows the concept. Wrongly understood concepts are show with red bars at the bottom of the screen. The general year-based diagnostics (figure 2, right) shows the performance in upper level themes.

Figure 2. In-game learning analytics in Eedu Elements game.

Academic analytics are meant to provide relevant information for practice and curriculum development for school administrators and national policy makers. The analytics (figure 3) can show the general score, like Pisa, for countries, but the real strength of the analytics are in details:

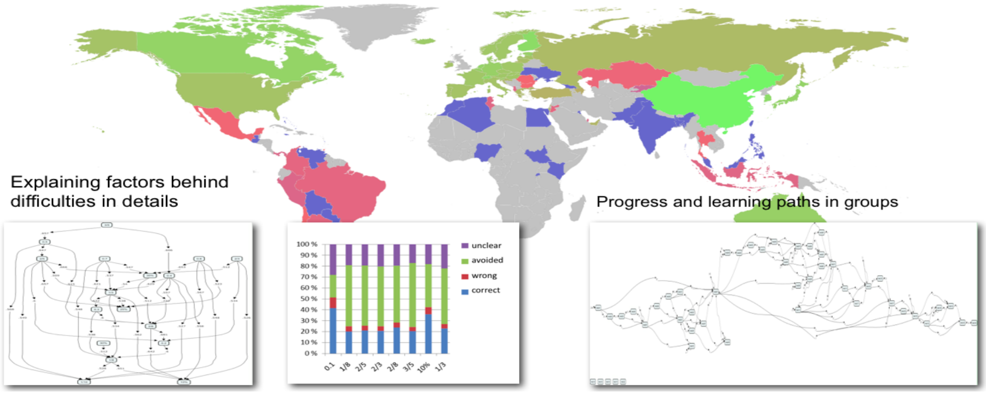


Figure 3. Eedu Elements' academic analytics overview.

CONCLUSIONS

In general, the paradigm on how an education is going to change is that school is no longer a place to learn and repeat single skills. Furthermore, there is no need to play the games only in school; games can be played outside the school and experiences can be discussed and shred at school. The skills and competences can be learned via play, e.g. in highly adaptive game environments, designed to support learners individual needs. School hours are for extending learners' mental conceptual structures via team work, social interaction, play, and active participation. Furthermore, games and other virtual environments can offer much more than just entertainment. They can provide relevant and meaningful information for individual learner, his/her parents, teachers and even for whole educational system in an national level. This, however, requires careful planning and years of research on game design and analytics.

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Developing a Mobile Learning Game on the Android Platform

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ABSTRACT

This paper describes the current phase of a long term project to create a reusable, configurable mobile learning game. The game uses a location aware augmented reality scenario in which players, in teams of two, role play business consultants to a technology company that is facing problems. Early versions of the game were developed on the Java Micro Edition platform, but this is becoming increasingly obsolete as a mobile phone programming environment. A decision was therefore taken to continue development of the game on the Android platform. In this paper we describe the issues that we faced in making this transition. Our results so far indicate that there are some problems caused by the wide range of mobile devices that run various versions of the Android operating system. Not all Android devices are able to successfully run the game, and some features (such as location awareness) work more effectively on some devices than others. We hope that sharing our experiences will assist others who wish to either use our mobile game or develop their own.

Author Keywords

Mobile learning game, location awareness, augmented reality, Android, Java

INTRODUCTION

The increasing sophistication of mobile phones means that many students now have access to smart phones with touch screens, location awareness, video, internet access, large amounts of memory and powerful processors. This makes it possible for us to design mobile learning experiences, using students' own devices, which were simply not realistic in the past. Many previous mobile learning projects that involved the creation of location aware augmented reality games relied on the provision of expensive and unusual devices by the learning provider, making such exercises limited in their scalability and reusability. Now, we can deploy complex mobile learning tools to everyday devices. Of course this ubiquity of smart phones does not, unfortunately, remove issues around choosing software deployment environments. There are several possible smartphone platforms and there is no obvious platform of choice for every circumstance. However Android has a number of potential benefits in the context of developing a mobile learning application that is intended to be easily accessible. Deployment to the Android store is easier and cheaper than deployment to the Apple or Windows stores and Android devices come in a range of models at different prices, many of which are more affordable than devices running other operating systems. In addition, Android uses many standard Java interfaces, making it the platform of choice for migrating existing Java applications. We have previously developed a mobile learning game using Java Micro Edition on Nokia S60 devices, but this platform is increasingly obsolete. We have therefore migrated the game to run on Android devices.

RELATED WORK

There is an increasing amount of work in Android mobile learning projects. Sandberg, Maris & de Geus (2011) used devices running an early version of Android to implement a mobile learning game to teach English in the context of visiting a zoo. Although the application was relatively simple, the use of a touch screen was important to the application, as it included activities such as a jigsaw puzzle that relied on this feature. An Android application using GPS, web services, photographs and messaging, is Gymkhanas, a multimedia mobile learning game (Robles, Gonzales-Barahona & Fernandez-Gonzales, 2011). This has some similarities with our own game in that it involves the exploration of a physical environment, though it is not targeted to a specific teaching context. For this application, ease of deployment to the Android store appears to be an important motivation. Brown et al (2011) describe the design of a location-based serious mobile game for people with intellectual disabilities and additional sensory impairments. Reference is made to specific tools available on the Android platform such as the 'eyes free' project. de Urturi, Zorrilla & Zapirain (2011) also use Android devices to assist those who have learning challenges, this time for individuals with Autism Spectrum Disorder (ASD). Their serious game is based on first aid education. The paper states that either Android devices or iPhones could have been used, but some of the test devices used are small screen tablets, a form factor not currently available for iOS devices. Thus specific factors in favor of the Android platform identified by others include ease of deployment, choice of hardware and specific software tools.

CHANGES TO THE GAME FOR ANDROID

Migrating our own game from Java Micro Edition to Android had a major impact on the nature of the learner's interaction with the game. User control had to be migrated from keyboard control to a touch screen. This required a complete redesign of the user interface. Instead of keyboard controlled menus, interaction with the screen is based on tabbed panes selected on the screen. Figure 1 shows the main game screen, displaying the 'Map View', showing the location of the player and their next destination. In addition there are further tabs ('Interviews' and 'Documents') that contain gathered artefacts that the user can switch to at will.

Figure 1. The main game screen with map and locations.

Adapting to the Android programming style was a significant challenge. Using XML to define all the screen layouts rather than doing this programmatically required considerable refactoring of the software. The Android life cycle was also a significant issue, since the event driven interaction of Android devices is more complex than on Java ME devices. Determining what actions should go where in event life cycle methods was problematical. For example, one unexpected side effect of failing to handle these events correctly was that tilting the device would cause videos to restart. Supporting the widely different versions and resolutions of different Android devices e.g. phone and tablet, was also a challenge. Enabling Google Maps required a particular key for the maps API in combination with generating a key for the 'APK' file that is deployed to the device. Failure to configure these properly meant that the map did not appear on the device.

TECHNICAL EVALUATION ISSUES

We used four different devices for testing purposes; LG-P500 (Android 2.2.1, 3.2 inch screen), Samsung Galaxy Tab GT-P1000 (Android 2.2, 7 inch screen), Samsung Galaxy S2 (Android 2.3, 4.3 inch screen) and Samsung Nexus S (Android 4.0.1, 4 inch screen). Given the operating system versions that were supported by the various devices, no features were used that were not supported by Android 2.2. One of the immediate problems of using different devices was that this intensified the device focus of the learner, distracting them from the learning task. In our evaluation the testers tended keep comparing the screen displays of the devices, the difference in performance of the GPS and the relative speed of battery drain. However, these issues with the devices notwithstanding, the results of the test were encouraging. Participants played autonomously, and did not need to be followed around to be given technical support. The application proved technically reliable and robust and was a marked improvement over the previously tested version.

CONCLUSIONS

We have re-implemented a mobile learning augmented reality game from an original version written using Java Micro Edition to one written for the Android platform. Our initial evaluations of this version suggest that the technical platform is proving effective and reliable. However the fragmented nature of the Android market, with many different devices and versions of the operating system can prove a distraction for learners, and some devices perform much better than others.

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MLE-Moodle in museum education and in a biology exam held in a field conditions

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ABSTRACT

This is a case study on the implementation of MLE-Moodle in museum education and in a biology exam conducted in field conditions. MLE-Moodle is an open-source GPL-licensed ready to use mobile Learning system designed for mobile phones. It is a plug-in for the open-source learning management system Moodle. MLE-Moodle is a new approach to mobile learning. It connects the mobile learning environment directly to the traditional web based learning environment. The pupils participating in the experiments were from 2nd - 5th grades and the biology class group was 8th graders; they welcomed mobile learning fairly well.

Author Keywords

Mobile Moodle, museum education, biology exam in a wood

MLE-Moodle is an open-source GPL-licensed ready to use mobile Learning system designed for mobile phones. It is a plug-in for the open-source learning management system Moodle, which is based on the social constructionist framework of learning. With MLE-Moodle it is possible to enhance an eLearning system to mobile Learning. Students can learn either with a mobile phone (mLearning) or with a PC /Notebook (eLearning). On a mobile phone student can either use the phone's own mobile browser to access MLE-Moodle or he/she can use a special **mobile phone application** which was designed for mobile phone learning (called MLE phone client). MLE-Moodle isn't merely a channel for collecting data to Moodle, but provides a means to use some of the Moodle's core activities (such as Quizzes, Lessons, Assignments, Surveys and Choices and Forums) with the mobile client.

MLE-Moodle could be an important step towards a wide use of mobile learning. If a teacher is familiar with Moodle, there isn't a very big leap to using MLE-Moodle. For students familiar with Moodle, MLE-Moodle is a natural way to use Moodle mobile way with their own mobile phones.

OUR MOODLE SERVER WITH MLE-SUPPORT

The Moodle server version used was 1.99 and MLE-Moodle was the version 0.8.8.3. Without the Gateway Server the mobile Client makes a direct HTTP-access to Moodle. I installed an own Gateway Server to the same server where our Moodle was, and it worked well. A Message Server informs the user about new messages. The advantage of the Messaging-Server is that you are informed about new messages even if you do not make a request to Moodle. Otherwise the users are informed about new messages only if they access the Moodle server. To use a Message-Server is not necessary, but here a public server msm.mo2i.com was used.

MLE-Moodle link appears in Moodle's front page, as well as a link from which MLE-Moodle Java-application can be loaded to the phone. When this software is loaded from that link, automatically our Moodle-server's web address, Gateway Server's address and other settings are transferred into the settings of Java-application. .Therefore the students can begin to use MLE-Moodle simply by writing their username and password.

CASE MUSEUM EDUCATION

The first test of MLE-Moodle was carried out at Kuokkala museum road. The pupils were 2nd - 5th graders from the nearby Nurmi village school. We used the phone's (Nokia 6220 Classics) own mobile browser to access MLE-Moodle. Moodle's discussion forum was used to implement the museum education course, so that each question formed one forum, and each team was to post there one post with a photo and a text. Furthermore, we added some introductory text to the questions that gave generic information about the museum objects, making it similar to a virtual museum guide.

“Take a picture of one strange object, invent a name for it and describe the purpose of the object”. The answer from Team Hippo was figure1 with a text that read: “A machine to make grated cheese. Put the cheese inside from the top, turn the lever, and out comes grated cheese”. “ The smithy of K. A. Koskinen _was working in this place *until* in 1910. What may have been manufactured in this smithy?” In figure 2 is the answer of the team: “soft ice cream”.

Figure 1.

Figure 2.

Figure 3.

CASE BIOLOGY EXAM IN A WOOD

In this second experiment we used MLE-Moodle Java-application with Nokia 6700 slide phones. Pupils in the experiment were an 8th grade biology class group (18 students). Tasks formed a part of the students’ evaluation and were as follows: 1. Tree height: Measure the height of a tree, identify it and take a picture of it. 2. Tree species: Identify 6 different species of trees at close range, take pictures of them and send the pictures and the name of the tree to Moodle. You can find help in your phone's browser bookmarks under the name tree species or directly at http://www.puuproffa.fi/arkisto/puulajit.php

Deployment of the MLE-Moodle Java application was not a straightforward process. We had trouble finding a phone to which Java application could be installed and in which the application would support a camera phone and the GPS system. The installation problems we encountered were at least partly due to the security certificate. When the date of the phone calendar *was* changed to the year before the current date, the application could be successfully installed. However, once the appropriate phone was found and the application had been installed, an embarrassing problem emerged. When the camera view of the application was used for taking a picture, the picture came from a different point than you had targeted! When the latest version of its operating system was installed to the phone, the error was resolved. The time required for solving this technical problem was approximately two working weeks. It is clear, that an ordinary teacher is not ready to do this kind of beta- testing which requires plenty of trial and error work. Mobile learning technology is not yet “plug and play” reality. Furthermore, in open source products bugs are an issue. MLE-Moodle community fixed a mobile tag decoding bug for us rapidly. But if the community of an open source product is not very active, you are on our own. With commercial products one can always complain to the sellers.

Only 25 % of pupils were satisfied as to how the phones were working, but all felt that it was nice to use them. Pupils want to use mobile technology in their studies also in the future. Only few pupils preferred to have tasks on paper. There were no pupils that wished never to participate in this kind of experiments again and they found mobiles easy to use.

The future of the MLE-Moodle

The future of the MLE-Moodle is unclear. Will there ever be support for the newest Moodle 2? Hopefully a new community of developers will take the source code and begin to develop it. Another “threat” to consider is whether there will be need for light user interfaces anymore, or are the power and the screen size of the new mobile devices making them useless? In developing countries the need of light user interfaces is clear also in the future, as it is in Finland if the pupils’ own mobile devices are used.

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Talking Tools – learning sloyd with smartphones

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ABSTRACT

Craft and design (sloyd) is a compulsory subject taught in grades 1-7 in primary schools in Finland. In grades 8-9 the subject is elective. The learning process in sloyd is highly student-centred and focused on individual learning processes during which tangible artefacts are manufactured e.g. in wood, textile materials, metal and plastic. Sloyd also includes basic mechanics and electronics.

The subject´s character is highly communicative and traditional teaching materials in the form of e.g. textbooks have a minor role. Because of the subject's student-centered and productive nature, teachers create most of the teaching material themselves, depending on the needs of the areas of work, the teaching context and students (Porko-Hudd, 2005, pp. 68–69) The teacher is often forced to repeat her instructions for individual students when teaching sloyd to a whole class. This is mainly because all pupils are not simultaneously in the need of the same information. On the contrary, students often need very different information under completely different times. The individual craft processes means individual learning needs.

Decreasing costs of smartphones and increasing capacity in data storage and wireless networks, pocket-size mobile devices are becoming powerful digital tools, creating new possibilities for learning (Pachler, 2009, p. 4) In the case of sloyd education, mobile technology might provide tools for changing the teacher´s role and the character of the communication between the teacher and student. The main idea in developing the mobile solution *Talking Tools* is to encourage learner autonomy by providing a learning platform including e.g. virtual learning objects and tools for work process documentation. The vision of the project is to create a smartphone application that on the one hand can enhance student autonomy and consciousness of learning. On the other hand to free teacher resources for renewing one´s teaching practice by shifting focus and characteristics in the teacher–learner communication.

Author Keywords

Sloyd education, mobile learning designs, learning object accessibility, UpCode

OUTLINING A MOBILE APPLICATION FOR LEARNING SLOYD

There is an added value of interdisciplinary collaboration when designing a learning platform and high quality learning objects for a mobile device. Sloyd education researchers at the Faculty of Education at Åbo Akademi University (ÅAU) are the initiators of the project *Talking Tools* and in charge of the didactical teaching materials that focus on presenting manufacturing processes. Furthermore they are planning the instructional design of the mobile application and researching the pedagogical use of the product. MediaCity at ÅAU also have several roles as studio staff is filming and editing the learning objects, format developers are involved in the instructional design, and researchers at the user experience laboratory are carrying out the usability and user experience testing during the iterative design process. The third part consists of UpCode Ltd., a software company known of their expertise in scanning technology similar to the widely used QR code.

One of the main ideas of the smartphone application Talking Tools is to give learners access to learning material via their mobile phone whenever they are about to carry out a task or a skill. Therefore *Talking Tools* will include a database of short, pedagogical audiovisual learning objects that help learners to manufacture the product they designed. The application will help the student e.g. to select the right ironing temperature or choose a correct saw. Whenever the student is in the need of information about tools, production techniques, the use of machines etc., he can simply run a keyword search in the Talking Tools learning object database. The search can be made anywhere, anytime.

UpCode Ltd.'s code-scanning technology also creates opportunities to turn the sloyd classroom into an interactive space with information embedded in UpCode-codes connecting learners from the physical classroom to digital learning objects about tools, techniques and materials. The UpCode- code stickers on different tools and machines makes information available in the location where it is needed in the moment e.g. at the tool cabinet or the sewing machine. For example if the learner is uncertain how to use the sewing machine, he scans the code on the sewing machine with his mobile device. He is then linked from the physical space into a digital space where he is provided pedagogical audiovisual information about how to use the sewing machine. This so called blended learning environment consists of physical face-to-face interaction and technology mediated instructions (Graham & Dziuban, 2008, p. 270). Graham and Dziuban suggest that blended learning environments can both improve learning effectiveness and increase access to information. The key factor is nevertheless in the case of *Talking Tools* how to combine the best of both worlds in order to create opportunities for improved learning experiences.

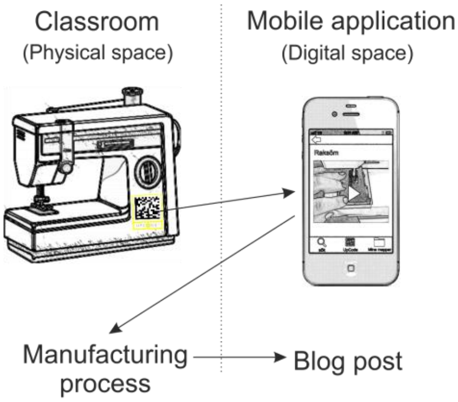

Figure 1. The learner shifts between the physical classroom and the digital mobile application.

Figure 1 shows how the use of the mobile application can be used in a classroom, The *Talking Tools* application combined with UpCode codes on the sewing machine creates a blended learning environment, a mixture of the physical space and the digital space. The learner shifts between the classroom and the mobile application via UpCode-codes, in this case a code sticker on the sewing machine. The information embedded in the code then hopefully helps the learner to perform a task or a skill needed in the manufacturing process. The learner can later document her work process in her blog in the application.

In order to promote student autonomy and a wider consciousness of learning, *Talking Tools* will also include a tool for work process documentation. The documentation tool allows the learner to post comments in her work blog about her design and manufacturing process, –what influenced her design and what problems she encountered and how she managed to solve the problem. Students can post short text comments and also post pictures, video and voice comments in their work blog during lessons, on the school bus or at home. This will hopefully help the student to evaluate and predict her work process. Since the teacher have open access to the students work blogs the teacher can keep track of the students work activity, give students feedback and give the students additional work assignments.

The benefit of using wireless, lightweight mobile devices in sloyd is that information is available in the environment where it is needed in the moment, at the tool cabinet, ironing board, or workbench. The question which the student then can ask the teacher reads no longer "What and how do I do next?" but "I've been meaning to do this, is that OK?" The teacher will therefore have a more affirmative role and the student in turn becomes more independent in their work. The learning object should not be seen as substitute for a professional teacher, nevertheless *Talking Tools* might shift the focus and characteristics in the teacher–learner communication by providing a tireless teacher that teaches the same thing over and over again.

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An Activity Theory based Approach to Introduce mLearning in Agriculture

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ABSTRACT
In the recent years, mobile technologies have effectively catered for the information needs of the agriculture-stakeholders. This study intends to see how to introduce mobile learning within the domain of agriculture so as to facilitate learning process, and supporting farmers' decision making. A preliminary survey has been conducted as a component of the pilot study to find out the subjects (i.e. Study community) and tools or technologies presently available among the study community. The findings of this preliminary study will be used in designing future mlearning interventions so as to strengthen the present agriculture extension system. We propose to use the activity model together with other methodologies such as participatory methods to design, implement, and evaluate mlearning activities

Author Keywords
mLearning, Agriculture, Activity Theory

INTRODUCTION
Mobile technologies are found to be providing cost-effective and efficient solutions in addressing the agriculture information needs of the stakeholders (Dhaliwal & Joshi, 2010) however, the possibility of using mobile phones as learning devices has got little attention so far. Hence we intend to see how to introduce mobile learning within the domain of agriculture so as to facilitate learning process, and support farmers' decision making. This paper presents the findings of a preliminary survey carried out as a component of the main study. The main objectives of the survey were to study the possibility of introducing mLearning among a group of young farmers.

LITERATURE REVIEW
Keegan, (2005) defined mobile learning as 'the provision of education and training on PDAs/palmtops/handhelds, smart phones and mobile phones. Taylor et al, (2006) defined mobility as learning mediated by mobile devices, mobility of the users, and the mobility of contents and resources in the sense that it can be access from anywhere.

Activity theory was widely used in designing mobile learning environments (Uden, 2007). It is also considered as a powerful and clarifying descriptive tool which provides an ideal framework to study the major dimensions of mobile learning i.e. learner, devices, and outcome as separate components as well as their interactions (Nardi, 1996).

METHODOLOGY
Activity theory has so far being used to structure this study, and to derive research questions (Figure 1). Accordingly the preliminary survey was planned to address two of the important concepts as proposed in the Activity theory i.e. subjects and tools.

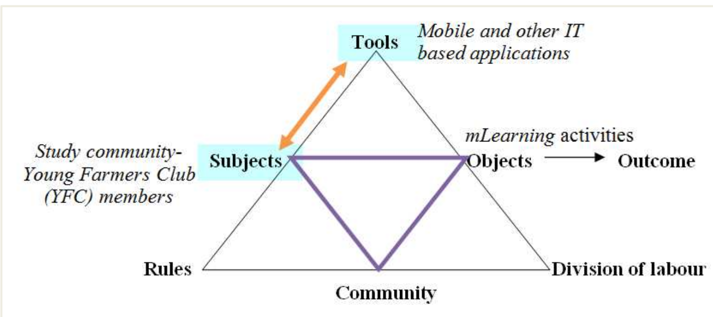

Figure 1. Concepts studied in the preliminary survey

The preliminary survey was planned to study the possibility of introducing mLearning among the members of Young Farmers Club (YFC) – Ancumbura AI range, in Kandy district Sri Lanka. This YFC was purposively selected for the study based on their involvement in agriculture activities for the past 5 years. Out of the 44 members of the Ancumbura YFC 22 members were randomly selected to participate in the preliminary survey. The background of the study group was studied in detail to learn their familiarity with technology, education level, attitudes towards using mLearning in agriculture etc. Tools and technologies which are presently in use among the YFC members were also studied including mobile and other IT based applications.

Key informant discussions were also used in data collection and data analysis was conducted using manual methods.

RESULTS AND DISCUSSION

Age of the respondents varied 16 -31, and almost all were well educated having passed GCE O/L examination. Nine out of 22 (41%) had studied agriculture as a subject in the school. The respondents were mainly in floriculture business and home gardening. Many school going YFC members were helping their parents for the family farm/ floriculture business. This information will be used when designing the mLearning lessons so that it is appropriate with their present knowledge level and interests. Sixteen members (72%) had mobile phones in their possession while the others had CDMA connections for the family. Although this is lower than the present market penetration of mobile phones in Sri Lanka, this can be considered as a very favourable value considering the fact that only the school going YFC members some (27%) YFC members were still school going.

The major mobile phone service providers were Mobitel and Etiselat two private companies. The average monthly expenses for the phone LKR 440 (range LKR 150 - 3000). The monthly expenses indicated the possibility of them committing for a mLearning programme. Table 1 shows their use of the different features available in the mobile phone.

Frequency of use	(%) of subjects using the various features available in mobile phones (n=22)				
	Voice calls	SMS	Camera	Radio / music	Internet access
Rarely	4.55	9.09	18.18	18.18	18.18
Sometimes	40.91	36.36	36.36	27.27	13.64
Often	50.00	36.36	0.00	4.55	4.55

Table 1: Use of the different features in the phone

The types of the phones used among the YFC members were investigated. Only one member had a smart phone, while six members had java enabled phones.

Almost all the respondents (95%) were willing to join with a mLearning programme to learn agriculture related information as their use of available agriculture information sources was limited. Only 5 members had called the Toll Free Agriculture Advisory service implemented by the Government Department of Agriculture and only eleven members (50%) had visited Cyber Agriculture Extension Centers available locally. The members were willing to use a mLearning platform which could be used to interact with the members as well as the instructors.

CONCLUSIONS

The findings of the preliminary survey suggests that it is possible to introduce mlearning among the study community as they are educated, familiar with the necessary technology, and most importantly have favourable attitudes towards using mobile phones to learn agriculture.

Based on the findings of the preliminary study we wish to design, implement and evaluate mlearning activities for the YFC members in the light of activity theory. The main concepts of activity model will be used in the various stages of development process and we try to capture the dynamics of mlearning situation using the activity model. Other methodologies, such as participatory methods and co-design methods will be used together with the activity model.

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LOCATION-BASED MOBILE LEARNING FOR HIGHER EDUCATION STUDENTS – DEVELOPING AN APPLICATION TO SUPPORT CRITICAL THINKING

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ABSTRACT
The increasing adoption of smart phones and tablets has opened up many opportunities for the use of new technologies in ways that can benefit. The challenge is to try and match the technology to educational activities that can be adapted to students' current practices and levels of ability, thus enriching their learning experience. Many higher education students' assignments require critical thinking and analysis and students with rudimentary skills need a high level of guidance and support. This paper presents the background to an intervention, which is currently in the early stages of design, to develop students' critical thinking skills using location-based mobile learning. It is hoped that this intervention, which will involve the use of a mobile application, will enrich students' independent learning experiences by providing contextually relevant knowledge to enhance their analysis in various situations.

Author Keywords
Location-based, critical thinking, mobile application.

INTRODUCTION
Mobile learning has become a burgeoning area of research in recent years. It is gaining increasing attention with the advancement of mobile technologies and the widespread use of smartphones and tablet PCs. It has been applied within many disciplines such as Science (Hwang et al., 2009; de-Marcos et al., 2010), Computing (Hwang et al., 2010; Yau and Joy, 2008), and Languages (Chen and Hsu, 2008; Guerrero et al., 2010) to name but a few. Research has been conducted both in schools and higher education. However, in comparison with secondary education, there is relatively little research regarding mobile learning in higher education (Yatani et al., 2004; Costabile et al., 2008; Shih et al., 2010; Hwang and Chang, 2011).
This paper presents an intervention currently being designed to develop students' critical thinking skills using location-based mobile learning, which showcases personalisation as one of the strengths of mobile learning (Kinshuk et al., 2009). The next section of this paper briefly explains the relevance of critical thinking to this study. This is followed by a summary of the related work in the area. Next, the initial concept is introduced, together with the aim and objectives of the proposed system. Finally, the research methodology and the rationale for the adopted approach are discussed.

CRITICAL THINKING
As this research aims to encourage and develop students' critical thinking and analysis, it is important to define what this means. There are several relevant definitions of critical thinking, some as early as Dewey (1933). However, for the purposes of this study one definition has been identified, Scriven and Paul's (1987) who defined it as "the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action". Their definition shows a clear relation to Bloom's taxonomy, linking critical thinking to the three higher levels of the taxonomy (analysis, synthesis, and evaluation) (Duron et al., 2006). This definition emphasizes the multifaceted nature of critical thinking, expressed through a number of activities. These activities correspond to the assessed work carried by students in this study.

RELATED WORK
This section provides a brief overview of a few selected research studies in the area of location-based mobile learning which best exemplify use in a learning environment. Chu et al. (2010) developed a location-aware mobile learning system for a natural science course for primary students. The system uses RFID tags on plants as the sensing technology. The system guides students to a particular plant encouraging them to ask questions and compare similar plants. They argue that the system promotes students' interest in natural science and improve their learning.
Shih et al. (2010) developed a mobile learning activity to guide primary students' learning in a historic site for a social science course. They claim that students' achievements have risen by 10%, with 90.6% of the students strongly agreeing that using the PDA, as a guide was more interesting.

Yau and Joy (2008) developed a framework for a mobile context-aware and adaptive learning schedule (mCALS) tool. The framework is designed to help students plan their studies. It retrieves their context to suggest which learning material is appropriate for the student, given their preferences, and the location.

A LOCATION-BASED SITUATED LEARNING FRAMEWORK

This section describes the initial concept behind this research and the motivation for applying such a system in higher education courses.

Motivation and Initial Concept

The idea for the research emerged from seeking to identify ways of exposing interaction design students to real world environments, similar to those in which they will eventually be designing, in order to maximise their ability to identify opportunities for innovation. However, sending students out into real-world environments with a brief to be evaluative and analytical, without the presence of a teacher, can lead to a superficial and frustrating experience, especially for students with beginning levels of analysis and limited critical thinking skills. It is not always possible for teachers to accompany students, and moreover, it might not be beneficial for developing students to have immediate input from teachers, but rather prompts to provoke the development of their own thinking.

Hence, a system that provides location-based hints and formative feedback to students could aid students' understanding of the context they are in. Without guidance, students might miss out on key areas that may help them with analysing the situation properly. The hints could give them the beginning of a thread that leads to the development of innovative ideas.

This proposed system will be designed for smart phones, providing students with structured support as they learn about their subjects in a real-world context. When students reach a pre-specified location, the application will display a detailed map identifying the various sub-locations which contains either text and/or images provided by their lecturer. These hints will be designed to aid them in widening their perspectives, developing their own ideas and in critical evaluation. The text notes will vary from simple words to questions, and in some cases to links that will open a quiz webpage; the particular content will depend on the specific aspect that the lecturer would want the students to focus on. Furthermore, to add a collaborative learning aspect to the activity, students will be able to post their comments for their lecturers and fellow students to take note of.

The motivation for developing the mobile application is as follows:

- We have chosen a situated learning pedagogical approach, a research topic that has been lagging behind a location-based and context-based for mobile learning paradigm in higher education.
- The application could help students stay focussed on the purpose and outcome of the activity, rather than be distracted by the process. Thus, maximising their benefit from the real world experience while still implicitly developing an understanding of the process.
- Students struggling to analyse the situation and develop new ideas have the appropriate guidance from the application.
- Sharing comments, ideas and maybe stories if desired, may enable students to benefit from their peers' knowledge and different perspectives.

The initial situated learning activity will be developed for a level 2 Human-Computer Interaction (HCI) module in the Department of Computer Science and Creative Technologies at the University of the West of England. As part of their work for this module, students are required to evaluate and carry out a context-based analysis as part of a requirements gathering process for a computer-based system.

Aim and Objectives of Proposed Research

The aim of this research is to investigate how smart phone applications should be designed to enable students to learn effectively in-situ.

To achieve this aim the following objectives have been identified:

- To construct a prototype for a pedagogical activity assisted by a mobile device to facilitate independent study.
- To consider various ways in which the prototype might enable reflection and critical thinking in a structured manner.
- To review the students' experience of using the prototype of locative media application in relation to effectiveness and usability of the system.
- To review students' perceptions of the formative feedback provided by the mobile application.

We are currently in the process of developing the working prototype.

Research Questions

- How effectively can mobile learning/technologies provide students with the necessary guidance in a situated learning activity without the physical presence of the tutor/lecturer? Effectiveness will be considered in terms of improving ability for critical thinking, evaluation and synthesis.
- What evaluation criteria and techniques can be used to evaluate such systems?
- How can the prototype be designed so that it is easily customisable for different activities and scenarios?

- The power of mobile learning occurs in personalisation. Based on the technology available to students, to what extent can the application be personalised?

Methodology

A number of research methods appropriate for human-centred design, have been reviewed to inform the research design. It seems best to implement this research using an iterative design and prototyping approach to ensure a high level of usability and utility. Within this approach the following phases are considered:

Requirement Gathering:

In order to have a deep understanding of the current learning activity as it is carried out, and to thoroughly underpin user needs, the first phase has involved a number of activities:

- A secondary literature review of mobile learning, applications and technologies, giving a comprehensive knowledge of the current state of the art. This knowledge is helping to shape the design and trigger ideas for the system.
- Interviews with the stakeholders (lecturers, students, administrators) involved in study. These help to give a better understanding of the structure of the activities carried out by each participating course, how the activity and students could benefit from implementing mobile learning, and the main problems faced by students in the activity. Interviews are significant in gathering requirements and understanding the needs of the users (Lazar et al., 2010).
- A survey to give a clearer picture of student ownership and use of smartphones in the locale of this research.
- Focus groups with previous students cohorts to help understand the difficulties faced by students when performing the activity prior to this research.
- A review of previous submitted coursework and feedback from lecturers on the work to give a better understanding of the weak points in students' work and the areas in which support is most needed.
- A comprehensive review of the relevant technology to identify suitable technologies to be adopted for the system.

Theoretical Framework Development:

The focus of this phase is to develop the details within a framework, based on the outcomes of the first phase. One significant framework that has been identified as being particularly relevant is the work of Ryu and Parsons (2008). Using this framework, the design of the requirements has been derived using the information gathered from interviews with the HCI lecturers.

System Design and Prototyping

In this research, an iterative design and prototyping approach is being followed. Conceptual design enables the translation of requirements into a conceptual model. A conceptual model is " a high-level description of how a system is organised and operates" (Johnson and Henderson, 2002 cited in Rogers et al., 2011).
Prototyping is an effective way to discuss design ideas with stakeholders. It helps in testing technical feasibility, understanding requirements, testing and evaluating, and assuring design compatibility (Rogers et al., 2011).
The iterative design and prototyping approach is a cyclic process of defining requirements, designing, coding, and testing.

As part of iterative approach of this project, paper prototypes, task flow models, and mock-ups are being implemented.

System Evaluation and Usability Studies

Usability testing will be performed on early prototypes of the system. This will include paper prototypes to test early concept through to working prototypes in the lab and in situ. Conducting a valid evaluation of mobile technologies presents a range of challenges in the field. This research is exploring a range of methods and it is envisaged that this will be a significant contribution.
Other methods for usability studies will also be employed such as observations and diary study methods. A set of appropriate usability criteria will be identified for the usability evaluation studies.

CONCLUSION AND FUTURE WORK

This paper outlines the background to the research being conducted in the area of location-based learning using mobile technology. The initial concept described in this paper is being designed to address the key components of a successful situated learning experience; this includes the necessity for the experience to take place in an authentic setting, in terms of contexts and activities, and to incorporate an element of collaboration between learners.
The application is focussed on helping students to develop their skills for critical thinking and analysis in real- world situations, and as such our priority in the first instance is to develop a clear theoretical framework that enables this. In taking a human-centred approach to the design we will be adopting an iterative design process to review the students' experience of using the locative media application considering the effectiveness and usability of the system, which will be critical to its success. We have completed the requirements gathering phase, translated the findings into an initial design concept and are in the process of developing the prototype.

As this work progresses we hope to better understand how smart phone applications should be designed to enable students to learn effectively in-situ.

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Human-Computer Interaction for Mobility and Learning

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ABSTRACT
Contextual learning activities supported by mobile devices are designed to include some kind of interaction with the physical environment. However, students may place the mobile devices in the foreground of interaction rather than interacting with the physical environment. We understand this as a problem of human-computer interaction, or more specifically of human-device interaction. This leads to the research question: How do we design for contextual learning supported by mobile devices? We approach this question from a design-based research perspective, where we design and evaluate contextual mobile learning activities together with teachers and students in four iterations. The contributions of this thesis are (1) a review of contextual mobile learning research, (2) a conceptualisation of contextual mobile learning from the perspective of human-device interaction, and (3) a model of human-device interaction that can be used in designing contextual mobile learning activities.

Author Keywords
Human-Computer Interaction, Design-Based Research, Mobile Learning

INTRODUCTION
The main reasons for introducing mobile devices to learning activities outside the classroom is that it enables new learning experiences, since it can place learning in authentic contexts, support peer collaboration, and motivate learning (Wijers, Jonker, & Drijvers, 2010). Simultaneously, one challenge of introducing mobile devices to learning activities is that the novel technology might detract from the new learning experiences (see *Figure 1*). This is the challenge focused upon in this thesis. We approach this challenge from a human-computer interaction perspective, where we arrive at a model for designing formal learning activities outside the classroom through an iterative process of design and analysis.

Figure 1: Student interacting with a mobile device in an outdoor environment

MOBILITY AND LEARNING
In the research field of mobile learning many different research traditions are coming together. These traditions bring different understandings of what is meant by *mobility* and by *learning*.

Frohberg (2008) presents four different views on mobile learning, where concrete mobile learning projects may be related to more than one of these views. In the first view, mobile learning is about accessing learning material from anywhere, for example on the bus. The mobile device is what makes this possible and learning is understood as transfer of information.

In the second view, it is the learning environment that is mobile. In this view we find games for learning, run on mobile devices. The learning tasks are either open ended or structured, with either not defining what is meant by learning or by relying on formal learning. As the learning environment is mobile in this view, no other media than the mobile devices are needed.

In the third view, it is the learner that is mobile. This view is about moving outside the classroom, to another physical environment where the understanding of learning is dependent on this physical environment. The role of the mobile technology is to allow the learner to connect with the physical environment, for example by using sensors. In the last view, the learning community is mobile. The mobile technology is used for accessing and creating a common learning environment, which means that learning is seen as co-created.

This paper is framed within the third view where the learner is mobile, more specifically the learner is mobile primarily in the physical environment. For this view of mobile learning we adopt the concept of contextual mobile learning.

Contextual Mobile Learning

Brown et al. (2010) describe location-based and contextual mobile learning as learners being continually mobile: "Rather than seeing learners as physically present in a certain place, such as a classroom or a museum, learners are active in different contexts and frequently change their learning contexts." (p. 3). Learners are mobile in the physical environment, however from looking at previous projects we see that it differs to what extent the physical environment is integrated in the learning activities. From a review of mobile learning research projects (Frohberg, Göth, & Schwabe, 2009) complemented by the review by Brown et al. (2010) we identify previous projects where learners are mobile in physical environment. These are projects where the physical environment is used as a backdrop, like Savannah (Facer et al., 2004) where children learned about lions by playing lions on a virtual savannah. There are also projects that uses objects in the physical environment, like MyArtSpace (Vavoula, Sharples, Rudman, Meek, & Lonsdale, 2009) where children could collect virtual items in a museum. And there are projects that integrates the physical environment to a large extent, like Ambient Wood (Rogers et al., 2004) where children explored a physical environment that had some added digital properties, as for example you could listen to photosynthesis in trees. Two recent projects focus on mathematics outside the classroom. These are MobiMaths (Tangney et al., 2010) and MobileMath (Wijers, et al., 2010), with low to medium integration of the physical environment.

The learning activities on geometry reported on in this thesis have a medium integration of the physical environment.

RESEARCH MOTIVATION

The review paper by Frohberg et al. (2009) reports that roughly one third of mobile learning research projects strive to move learning away from the classroom to more natural environments. In the same review paper the authors noted that there is "very little work which discusses the placement of mobile tools as means of control" (p. 318) and that "[v]ery few Mobile Learning projects with physical context explicitly considered, positioned or focused the usage of mobile technology as instruments to gain transparency and steer flexible learning activities there." (ibid, p. 318). As noted in these research projects the field trials are done with small groups of students to facilitate collaborative learning. Some of these projects use mobile devices to not only present information about tasks to users, but also to control the flow of the learning activity in detail. This type of design is related to device-centric approaches that lead small groups of learners to place the mobile devices in the foreground of interaction, at the expense of their social interaction and interaction with the environment. It is notable that mobile devices in the foreground of human interaction are just reported on in peripheral notes in research reports from these projects, and consequently what it means that human-device interaction is in the foreground in contextual mobile learning activities is seldom questioned or understood as a main research problem (Göth et al., 2006).

Related work

A few projects have explicitly addressed the problem of mobile devices in the foreground of interaction. Cole and Stanton (2003) compares projects they have been contributing to; KidStory, Hunting the Snark and Ambient Wood, and report that the students had problems focusing on anything else but the mobile device. Their analysis showed that the problem was that the device was displaying a continuous flow of information and their solution was to deliver information only occasionally.

Hsi (2003) reports from observations on a mobile museum guide that there is a risk that the learning opportunities offered by the physical space is turned into "'heads-down' one-way transmission of information via a tiny display" (p. 317). The solution offered was careful instructional design. In the project Caerus (Naismith, Sharples, & Ting, 2005) focus on the mobile tourist guide was reported to be a problem, with "a large amount of 'heads-down' interaction" (p. 58). Rethinking implementation and investigate both technical and non-technical navigational aids were the suggested solutions.

Göth et al. (2006) report on a campus guide called the Mobile Game that: "In the current version of the MobileGame the focus of the players is permanently on the device." (p. 159). They suggest the following five solutions: plan for discontinuous usage, plan focus switches, use technologies only if it brings added value, do not use animations if the application is in the background, and reduce features as much as possible. In a follow-up study Göth and Schwabe (2010) redesigned the automatic updates of screen contents to students manually pushing an update button. The change resulted in a marginal improvement in how much the students were distracted by the device.

This review of related research work suggests that mobile devices in the foreground of students' interaction is a problem that is noted by other researchers. However, with one exception the solutions suggested are not elaborated. In the only exception, Göth et al. (2006), the suggested solutions are not implemented and in the follow-up (Göth & Schwabe, 2010) the evaluation resulted in only a marginal improvement.

RESEARCH QUESTION

Contextual learning activities supported by mobile devices are designed to include some kind of interaction with the physical environment. However, students may place the mobile devices in the foreground of interaction rather than interacting with the physical environment. We understand this as a problem of human-computer interaction, or more specifically of human-device interaction. This problem leads to the research question: *How do we design for contextual learning supported by mobile devices?*

RESEARCH GOAL

- Contribute to a conceptualisation of contextual mobile learning from the perspective of human-device interaction.
- Develop a model of human-device interaction that can be used in designing contextual mobile learning activities.

RESEARCH METHOD

In collaboration with a local primary school we have developed a design of a contextual mobile learning activity in four iterations; with one iteration per year. The first two iterations were framed within a project on geometry followed by the last two iterations within a project on biology (*Figure 2*). In all four of the design iterations we worked together with teachers and students in developing and refining a sequence of learning activities supported by mobile devices.

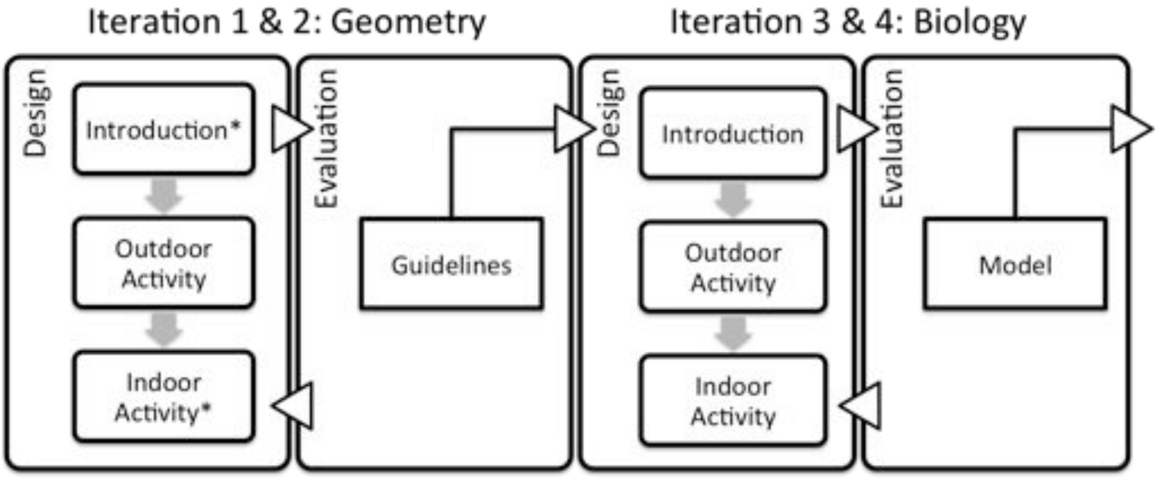

Figure 2: Research process (: introduction was not part of the first iteration and indoor activity was not part of the second iteration)*

In approaching the research questions we designed and implemented contextual learning activities, by adopting design practices from design-based research (Design-Based Research Collective2003), where we relied on co-design (Penuel, Roschelle, & Shechtman, 2007) for the design iterations (see *Figure 2*). By design practices we refer to working in iterative cycles together with teachers in creating a sketch and later a prototype that can be tested and eventually deployed in schools. The Design-Based Research Collective (2003) discusses design research in education and states that "[t]he challenge for design-based research is in flexibly developing research trajectories that meet our dual goals of refining locally valuable innovations and developing more globally usable knowledge for the field." (p. 7). The Design-Based Research Collective (2003) argues that design-based research blends empirical education research with the theory-driven design of learning contexts. Design-based research has proven a suitable methodological approach for the field of mobile learning, since design-based research attempts to combine the intentional design of interactive learning contexts with the empirical exploration of our understanding of these contexts and how they interact with the individuals (Hoadley, 2004). Design-based research follows an iterative cycle of identifying, developing, building and evaluating similar to that of interaction design processes. *Figure 2* shows the design-based research process as design and evaluation phases, where the outcome of the activity design (introduction, outdoor activity and indoor activity) is shown for the design phase and the outcome of guidelines or a model is shown for the evaluation phase.

ANALYSIS AND PRELIMINARY RESULTS

The analysis relied on different methods. Initially we used interaction analysis (Jordan & Henderson, 1995) where three researchers that had been part of the data collection in the field worked together on recorded video and audio material. In the first iteration we used the analysis foci suggested by the method (Eliasson, Spikol, Cerratto Pargman, & Ramberg, 2010) and in the second study we used the analysis foci related to mobile devices in the foreground of interaction. In the second iteration we added a more detailed analysis of the video episodes where the students' visual focus on devices was especially strong and episodes where it was notable that focus on devices was absent (Eliasson, Cerratto Pargman, Nouri, Spikol, & Ramberg, 2011). In the third analysis we transcribed interaction with devices from video data and mapped the transcription to a model of six categories of interaction we suggested (Eliasson & Knutsson, 2012). The result was a concrete measurement of to what degree the students interacted with the devices and the physical environment in the ways intended in the design of the activity (Eliasson et al., 2012). In the fourth iteration we will analyse transitions between interaction with devices and interaction with the physical environment by comparing two conditions: students identifying species of trees by using QR codes and by not using QR codes. The QR condition was designed using our model of human-device interaction. Thus we hope to see more than just marginal improvements in the QR condition over the non-QR condition.

DISCUSSION OF CONTRIBUTIONS

The contributions of this thesis are (1) a review of contextual mobile learning research (2) a conceptualisation of contextual mobile learning from the perspective of human-device interaction and (3) a model of human-device interaction that can be used in designing contextual mobile learning activities.

The contribution of the model is different from other approaches in that it is developed through a design-based research approach focusing specifically at the problem of human-device interaction in contextual mobile learning. Our model is better tested than other approaches since it is evaluated empirically through design iterations and field tests with students.

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Nurses' Informal Learning using Mobile Devices

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ABSTRACT
This paper provides an overview of a mixed methods study focusing on how registered nurses (RNs) use mobile devices for informal learning in the healthcare workplace. The significance of mobile devices as learning tools for RNs' informal learning to inform professional development and continuing competence is discussed.

Author Keywords
Informal learning, mobile devices, nurses, mixed methods, sequential explanatory

INTRODUCTION

In the Canadian healthcare workplace, in-person workplace-based education and training of nurses is becoming less readily accessible. This has created the need for RNs to seek other means for continuous learning for professional development and ongoing maintenance of competence (Canadian Nurses Association & Canadian Association of Schools of Nursing, 2004, p. 2). In the healthcare workplace, RNs are using mobile devices for a variety of purposes, including as learning tools (Doran, et al., 2010); however, how they use these learning tools is not well known. In response to these challenges and to address the paucity of research in this area, this mixed methods study explored how RNs use mobile devices for informal learning in the healthcare workplace. In doing so, this study adds to the theory base of informal learning and to the body of knowledge on workplace learning.

BACKGROUND

In the workplace, most learning is informal in nature (Cross, 2007). Although the preparation for a job or career typically involves formal education or training, once employment is obtained, informal learning is the primary way in which skills and knowledge are sought. It includes "any activity involving the pursuit of understanding, knowledge or skill which occurs outside the curricula of educational institutions, or the courses or workshops offered by educational or social agencies" (Livingstone, 2000, p. 2).

As a regulated profession, RNs in Canada are required to maintain competency through mandated continuing education and reflective practice for professional development (Nelson & Purkis, 2004). Moreover, the RN regulatory bodies have moved away from clocking hours for continuing professional education participation towards continuing competency programs where RNs have the autonomy and flexibility to identify individual learning needs and select appropriate continuing professional education activities to meet those needs. Attendance at workplace face-to-face education and training programs has become limited due to the barriers of "workplace budget constraints, lack of employer or administrative support, and lack of time due to staff shortages, shift work, scheduling difficulties, and family responsibilities" (Penz et al., 2007, p. 58). Consequently, informal learning provides an appealing alternative for these challenges and offers optimal flexibility for meeting the learning needs of RNs for ongoing professional development and competency.

Within the healthcare workplace, mobile devices have become more commonplace, expanding the boundaries of just-in-time learning and enabling users to interact with others, connect to information of their own choosing, and capture ideas (Traxler, 2010). With the ongoing healthcare workplace challenges, it may be necessary to move from traditional models of teaching and learning and consider other pedagogical practices and learning models, including informal learning using mobile devices to assist RNs to meet their ongoing needs for professional development and continuing competence.

RESEARCH PURPOSE AND QUESTIONS

Within the context of the healthcare workplace, this mixed methods study was conducted to initiate and/or add to the body of research by exploring how RNs engage in informal learning using mobile devices in the healthcare workplace. The study's research questions that were drawn from the theory on informal learning are listed below.

1. What informal learning strategies or processes do RNs engage in when using mobile devices in the healthcare workplace?
2. For what purposes do RNs employ informal learning strategies or processes using mobile devices in the healthcare workplace?
3. Are there differences between how RNs use individual and collaborative modes of informal learning with mobile devices in the healthcare workplace?

4. Is there a relationship between the age of RNs and their use of mobile devices for informal learning in the healthcare workplace?

THEORETICAL FRAMEWORK

This study's theoretical framework is multi-faceted, drawing from theories of workplace learning and informal learning within the field of adult education, and also involving mobile devices and their use as learning tools. The workplace is an important context for the intertwining processes of learning and work (Streumer & Kho, 2006). Learning where people actually work includes the training and development perspectives of human resource development and continuing professional education (Bierema & Eraut, 2004).

Informal learning includes learning that is self-directed and intentional, incidental or unplanned learning that becomes conscious after an experience, and tacit learning that is neither intentional nor conscious (Schugurensky, 2000). Watkins and Marsick's (1992) theory of informal and incidental learning in the workplace identifies the following characteristics:

> based on learning from experience; embedded in the organizational context; oriented to a focus on action; governed by non-routine conditions; concerned with tacit dimensions that must be made explicit; delimited by the nature of the task, the way in which problems are framed, and the work capacity of the individual undertaking the task; and enhanced by proactivity, critical reflectivity and creativity (p. 287).

More recent models of informal and incidental learning in the workplace include the concepts of tacit/implicit knowledge, whole-person learning theory, and communities of practice (Marsick, Watkins, Callahan, & Volpe 2006).

The creation of knowledge and meaning that occurs through the informal learning using mobile devices can be viewed from the perspective of cognitive and socio-cultural constructivism. Cognitive constructivism contends that learners construct new knowledge individually based on previous learning; whereas, socio-cultural constructivism asserts that knowledge is constructed collaboratively through social discourse (Crawford, 1999). Depending upon the context, either theory may help to explain the processes involved in the use of mobile devices as a tool for informal learning. Clough, Jones, McAndrew, and Scanlon (2009) explain that mobile devices as a learning tool can potentially support and enhance learner-centred control, allowing learners "to engage with both the social and the physical contexts of the learning they are undertaking … and to decide whether and how to collaborate with other learners, to pool and share resources, or simply engage in individual reflection" (p. 361).

METHODOLOGY

The mixed methods, sequential explanatory research design included two phases with a quantitative online survey and qualitative interviews. The cross-sectional survey identified demographic information, informal strategies, processes, purposes, and individual/collaborative modes of informal learning of RNs who used mobile devices in the healthcare workplace. The qualitative data obtained from the semi-structured telephone interviews provided further explanations of the quantitative results. Both of these data collection methods operationalized the research questions.

The population was composed of approximately 1450 diploma-prepared and practicing Canadian RNs in a Bachelor of Nursing program at a single-mode distance university in Western Canada. For the cross-sectional online survey, subjects were recruited using email. Quota sampling obtained a minimum of 15 participants reporting collaborative modes of informal learning and a minimum of 15 participants in each of the age-generational categories of Generation Y, Generation X, and Baby Boomers. 170 useable online surveys were obtained and quotas were reached.

A survey questionnaire was developed containing three sections: respondents' background information, mobile device usage, and learning modes. The strategies/processes for the informal learning mode included: (1) reflect on previous action and knowledge using notes, diary, or some other method using my mobile device; (2) learn by trial and error; (3) view a video, webcast or podcast; (4) search the Web (including the Intranet); (5) search an online database (e.g., Medline); (6) read books, magazines, and/or journals; (7) observe others on the job such as photos; (8) talking on the phone with others; (9) interacting with others via emails; (10) asking questions in a professional listserv or online community. The first seven strategies/processes were considered individual modes of informal learning while the last three processes were considered potentially collaborative modes. The purposes for informal learning using mobile devices included: (1) new procedure/treatment; (2) accessing resources for evidence-based support; (3) professional development; (4) patient/client teaching; (5) maintaining competence. The questionnaire was field tested for content validity.

From the online survey responses, interviewees were selected using maximum variation purposive sampling based on diversities in gender, generational-age, location, work setting, position, years employed as a RN, type of mobile device used, length of mobile device usage, and frequency of use for individual and collaborative modes. Purposive sampling continued until data saturation was achieved. Ten subjects were interviewed. The semi-structured interview questions were piloted prior to administration. The interviews were digitally recorded, transcribed, and member checked. As a token of appreciation, respondents completing the online survey had the option of participating in a draw for an iPad® and interviewees had the option to receive a $40 gift certificate. Ethical considerations were also addressed.

Analysis of the study data included descriptive and inferential statistical analysis of the non-parametric online survey data, inductive analysis of the semi-structured interview data, and integrated analysis of both datasets.

RESULTS AND DISCUSSION

The descriptive profile of the study RNs indicated the majority were female Baby Boomers employed for over ten years as staff nurses in urban Canadian hospitals. These RNs primarily used Smartphones in their workplaces, for less than two years. Using Rogers' (2003) adoption categories, nearly 98% of the subjects could be considered as innovators or early adopters in terms of their mobile device use for informal learning in the healthcare workplace; a possible study limitation as the subjects may be more receptive to new technologies including mobile devices than the general nursing population.

Based on a four-point Likert rating scale from never (1), sometimes (2), often (3), and always (4), Wilcoxon Signed-Ranks revealed statistically significant differences at the 5% level (Z= -11.312, N = 170, p=.000) indicating more subjects used the strategies/processes for informal learning without a mobile device in the healthcare workplace (M = 31.37, SD =5.15) than those using a mobile device (M=22.21, S =6.49). Such a finding is not surprising, considering as Doran et al., (2010) suggest, the use of mobile devices in nursing practice is relatively new in the healthcare workplace.

The interviewees and survey respondents indicated frequent use of their mobile devices for *searching the Web (M*=2.88, *SD*=.867*)* and *searching an online database* (*M*=2.56, *SD*=.956). In the survey responses and narratives, the least used process was *asking questions in a professional listserv or online community* (*M*=1.87, *SD* =1.022). Berg and Chyung's (2008) study obtained similar results with professionals using this process the least frequently for informal learning. The subjects reported participating in self-directed informal learning using their mobile devices that was planned, intentional, and conscious in response to new and changing situations in the healthcare workplaces. This experiential learning was evaluated through reflective practice. In the survey, the incidental process of *trial and error* was the second lowest frequency reported (*M* =1.90, *SD*=.896). Only one interviewee reported using *trial and error* for informal learning with a mobile device. No indications of tacit learning were found in either the quantitative or qualitative analysis.

The purposes for informal learning using mobile devices cited most frequently were *accessing resources for evidence-based support* to promote the delivery of patient/client care and for *professional development* for knowledge and skills acquisition to inform their professional practice. A Chi-square test revealed that *accessing resources for evidence-based support* (X^2 (1, N = 170) = 10.376, p = 0.001), and *professional development* (X^2 (1, N = 170) = 7.624, p = 0.006) were statistically significant at the 5% level. As in Berg and Chyung's (2008) study, participants may be more likely to engage in informal learning strategies/processes for gaining new knowledge that was necessary to perform at a higher level in their professional practice. Quantitatively and qualitatively, the least reported purpose of informal learning using a mobile device was for *maintaining competency* (X^2 (1, N = 170) = 7.624, p = 0.006). The interviews suggested a general unawareness of the potential contribution of informal learning using mobile devices for professional practice competency and registration requirements. This deficit may have influenced the responses for the purpose of *maintaining competency*.

Quantitatively, collaborative modes (M = 2.33, SD = .885) were used, on average, slightly more than individual modes (M =2.21, SD=.696). The interviewees reported using all of the individual modes for informal learning with mobile devices. Only two narrative accounts included the use of colloborative modes, *interacting with others via emails* and *asking questions in a professional listserv or online community*. However, five interviewees stated that they emailed via their mobile devices for communication purposes only with clients and peers. Relevant to these findings is the Clough et al., (2009) study on PDA and Smartphone use with informal learning that stated some participants used their devices to communicate, but lacked awareness as to their participation in collaborative informal learning. The divergence in findings suggests the need for further research. For the purposes, the Mann-Whitney U-test revealed that only professional development was not significantly different at the 5% level (U= 2365.5, p = 0.056). Interviewees reported using primarily the individual modes for the purposes of informal learning using their mobile devices to construct new knowledge based on previous learning, as described in the perspectives of cognitive constructivism. Wihak and Hall (2011) assert that individual modes are the preferred form of self-directed informal learning.

Minimal differences were found related to age-generational categories for informal learning using mobile devices in the healthcare workplaces. No differences were noted in the narrative accounts. Kruskal-Wallis tests revealed a statistically significant difference at the 5% level for only the process of *interacting with other people via email* (X^2=6.947, p =0.021) and the purpose of *professional development* (X^2= 6.078, p =.047) suggesting Generation Y uses this process and purpose less than the other age-generational categories. No significant differences were found among the age categories related to the individual or collaborative modes of informal learning. Livingstone's (2000) Canada-wide survey found Canadians under the age of 24 years spent significantly more time in informal learning activities than older adults but no differences were found for the other age categories. As there were no RNs in this study under 24 years of age, the findings on frequency of use of mobile devices for informal learning related to age were similar to Livingstone's results.

The narrative accounts indicated the lack of educational resources in the healthcare workplaces influenced the use of mobile devices for informal learning. All but two of the interviewees used their own mobile devices and data service plans to engage in informal learning in their workplaces. The lack of Internet connectivity and/or lack of employer support may have influenced the interviewees' selection of informal learning strategies/processes. Positive perceptions of efficiencies, self-confidence, patient/client safety, and reactions by patients/clients were cited by the interviewees. Also, the need for the sanctioned resources for using mobile technologies in the healthcare workplace was articulated.

CONCLUSIONS

In this mixed methods study, RNs expressed the importance of informal learning using mobile devices in the healthcare workplace for acquiring knowledge and skill development. Furthermore, as the use of mobile devices becomes more ubiquitous, there is the potential for this powerful tool to rapidly accelerate participation in informal learning in nursing practice. Recommendations for practice and future research include: (1) RNs acquire more information and/or education from their nursing associations on self-directed informal learning including how to apply this learning for continuing competency requirements for self-regulation and professional practice, (2) further exploration of the expressed need for sanctioned resources (3) investigations into the workplace influences (4) research into the motivations for engaging in this learning, (5) further study of individual and colloborative modes. Additionally, investigations with other professionals and longitudinal studies are needed on informal learning with mobile devices in the workplace.

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Mobile Learning as a chance to enhance education in developing countries – on the example of Ghana

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ABSTRACT

Education has become one of the biggest public enterprises in Ghana, taking about 11 percent of the GDP, enrolling about a quarter of the population in schools and other educational services (EDU 2011). The need for content, the demands of young people, requesting material for self-conducted learning, the lack of teachers, the small proportion of trained teachers and the lack of equipment in schools in rural areas are a huge challenge. The advancement of technology and high mobile penetration rates in developing countries has broadened the horizon of education. One possibility to overcome the problems is the application of the concept of mobile learning (called m-Learning). At first, it is required to describe the current situation in Ghana; this includes the identification of stakeholders as well as corresponding and influencing factors, which have to be taken in consideration when planning a holistic m-Learning-model for Ghana. M-Learning implies inherently a chance in the didactical approach. In the next step, together with a group of teachers in Ghana, research will be done, aiming at the implementation of a sustainable m-Learning concept for secondary education. Integrating teachers in the first phase is a necessity, since it supports the development of a pedagogical concept, which is necessary for a change in pedagogical practice to integrate m-Learning in daily practice.

Keywords

m-Learning, developing countries, educational needs, didactical change, mobile phones, educational content, content design, access to learning objects, secondary schools, teacher education, informal learning.

INTRODUCTION

To tackle educational challenges, systemic integration of ICT has been outlined as an opportunity for improving the quality of teaching and learning as well as expanding access to learning opportunities (UNESCO 2011). Bearing in mind that secondary school attendance and completion are strongly influenced by poverty, location and gender (EFA, 2011), mobile based solutions help to compensate the lack of infrastructure. M-Learning has been described as having the potential to “reach people who live in remote locations where there are no schools, teachers, or libraries” (Ally, 2009). Osiakwan from Accra, Ghana, stated in his presentation during the eLearning Africa Conference in May 2012: “The implications for literacy increase through the transition away from only voice and SMS phones towards more sophisticated smart-phones, where educational content can be accessed and learning achieved.” He pointed out the mass of online content and the potential for a young person in the remotest part of Africa, enabled by mobile broadband and a smart-phone, to appropriate the same knowledge as elsewhere in the world (Osiakwan, 2012).

Based on careful literature research of m-Learning projects in developing countries and former personal experience (Grimus, 2010) this research work is directed on exploring opportunities of m-Learning with mobile phones especially in the area of Ghana. Due to the fact that previous projects were successful, but not sustainable, our project is aimed to develop a sustainable model for integration of m-Learning in Ghana. The investigation of the proposed stakeholders will be first done with school teachers in Ghana.

RESEARCH QUESTIONS

Primary Question

Which necessary factors have to be considered for a sustainable implementation of a comprehensive area-wide m-Learning concept for countries in Sub Sahara Africa (on the example of Ghana)?

Subquestions

Prerequisites:

Technological Aspects: What are technological requirements to enable access to educational content with mobile phones?
Individual Aspects: What kind of devices are currently in use? What are the requirements for content?
What are the key drivers and barriers in the uptake of m-Learning services for students/teachers/school-authority?

Quality in Secondary Schools and Sustainability

What are the preconditions and requirements for getting access to educational content (e.g. learning objects)?
What lessons could be drawn from experiences to date in Sub Sahara African countries (SSA)?

What has to be implemented in the curriculum of secondary schools?
How can content provided for secondary schools be alternatively offered for informal learning?
How can institutions and educators create conditions for appropriate technology enhanced learning?
How can teachers be prepared to enhance education by integration of m-Learning in Ghana?
What are the consequences for education?

IDENTIFICATION OF THE SIGNIFICANT PROBLEMS IN THE FIELD OF RESEARCH

Former policies of ICT-in-education-initiatives focused on establishing PC labs in schools (and universities) to enable improved teaching and learning in classroom settings. Access to PC's or laptops in Ghana at home is not common: 9.1% in 2010 (ITU 2011), otherwise the ratio of mobile cellular subscriptions to fixed telephone lines in Ghana is 74.3:1. Nowadays declining costs for mobile devices and data plans, the near-ubiquitous access to mobile phones, especially among the region's youth, holds potential for expanding learning opportunities to underserved communities that are at risk of exclusion from affordable, high quality learning experiences.

Due to these facts focus of our research activities is laid on m-Learning with mobile phones in Ghana, and the needs to be taken in consideration when planning a sustainable solution. After a careful literature research (Ho et al., 2009) large-scale integration is far from reality, based mainly on the lack of infrastructure (schools, teachers and learning material) in developing countries. In rural areas of Ghana's North, quality of education is reported as to be rather low (EDU 2011).
In general it can be figured out that there are two main-levels for establishing m-Learning in a wider range. First the infrastructure and availability of devices (and related costs) and secondly the education related factors. Nevertheless if m-Learning is seen as a holistic approach which can change the educational system, stakeholders and their depending parameters must be identified. Figure 1 presents a first overview of the stakeholders as well as their related factors.

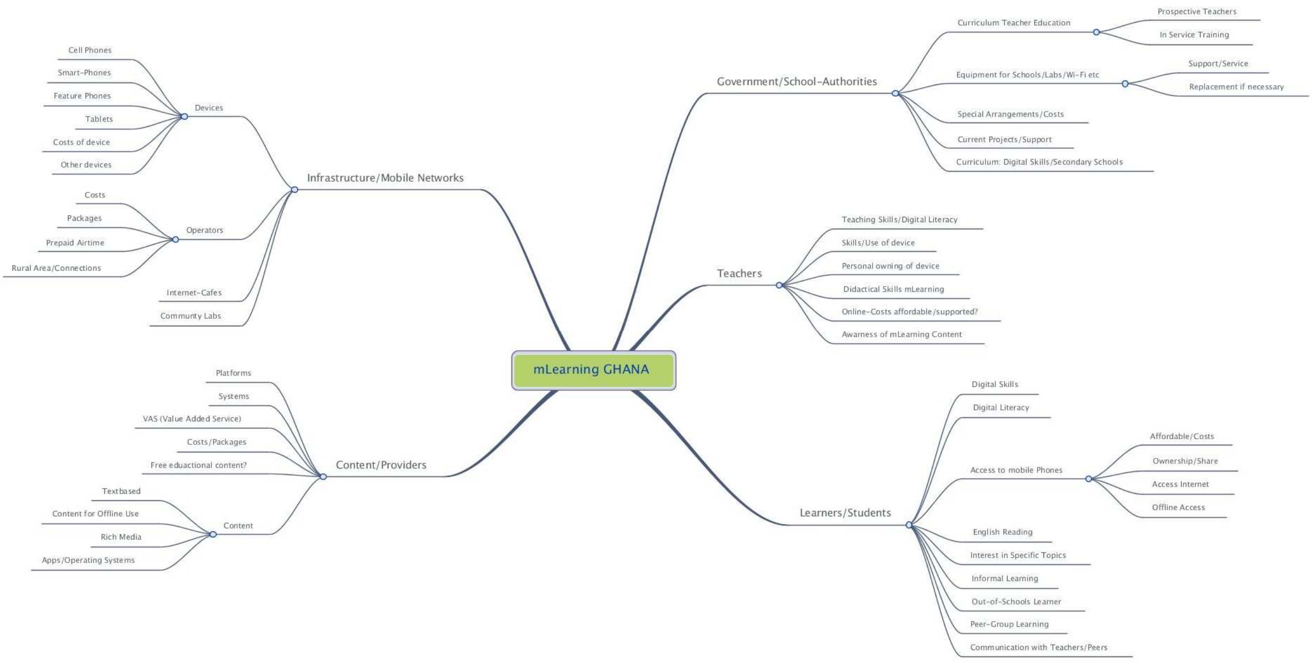

Figure 1: mLearning in developing countries, stakeholders and related factors, Ghana

Stakeholders and corresponding factors are interacting, each with unique interests and needs, in the complex system of m-Learning:

- Government / school authorities: equipment of schools (Pc labs, Wi-Fi; service, replacement, device management capability); finances; curriculum development/ teacher education (prospective teachers / in-service training), quality of education, curriculum for (secondary) schools/digital skills, approbation of projects)
- Infrastructure / technology: mobile devices (specification / attributes of device, costs: cell phones, smart-phones, feature-phones, other device; memory); mobile network operators: connectivity (costs: packages, prepaid airtime), rural areas: bandwidth, Internet-cafes, community buildings with free Wi-Fi
- Teachers: teaching skills / didactics (digital literacy, use of device); didactic of m-Learning (online communication, knowledge and evaluation of online-content, access to device outside of school)
- Learners / students: digital skills (digital literacy, digital reading); access to device (ownership / share; cost of data plans, access to Internet / offline use of content); language (English); interest in specific topics (out-of school-kids; peer-group-learning; communication with teacher(s) / cooperation with peers); formal learning (schools), informal learning (self motivated); policies for appropriate use

- Content provider: access to appropriate content, instructional design, operating systems (standardisation); platforms / systems, local relevance of the content, providing content for offline learning (text-based, rich media, messaging, apps); free educational content; costs / special packages (Value Added Service, VAS, operators offering developing countries packages with low subscription costs including learning content)

Careful research will help to understand interactions and challenges, relevance for the whole system and existing solutions. The outcome is a framework, providing the foundations for transitions into m-Learning in Ghana.

BRIEF OUTLINE OF THE CURRENT KNOWLEDGE OF THE PROBLEM DOMAIN– STATE OF EXISTING SOLUTIONS

Within a dispersed population as in Ghana, mobile phones are prerequisites to implement sustainable m-Learning solutions. For example Lauren Dawes reports, the highest level of access to a mobile phone or SIM Card amongst young people was found in Ghana, where it reached 90% (Dawes, 2011). Mobile penetration rate of Ghana in general is reported with 88% in 2012 (population of Ghana: 24.722.485), (Ghanareporters, 2012). In contrast most of the teachers do not have internet-enabled computers to access cost-effective online open educational resources (OER). Mobile learning should address the learner and their personal relationships (peer groups, teachers, etc.), what the learner is learning (topics, relationship to prior experience, etc.), and where and when learners are learning (Laudrillard, 2007). According to Laurillard various aims for implementation of m-Learning can be figured out as a chance for developing countries, to compensate specific needs, as there are lack of books, distance to schools, girls education, drop out-rates, e.g.. Lauren Dawes investigated how mobile technology affects the daily life of young people in remote areas and to achieve further aspirations. For Ghana her key-findings figured out: 35% of the youth named education as their key priority, 63% believed that they could learn through even a basic mobile device, 39% were most interested in m-Learning services, which would develop their professional skills, and 27% were most interested in language lessons. As a barrier for accessing information 46% named financial constraints/poor background, while 72% named the mobile phone as the most important asset (out of 5 choices: mobile phone, TV, clothes, radio, bank account). As barriers for m-Learning were identified: limited features (50%), limited content (44%), screen size (22%), and phone usability (28%); 73% recognised the potential of learning through their mobile, compared to 4% who did not (Dawes, 2011). For young people, not having the chance to continue formal learning and for the "out of school's" it is their chance to continue learning by using their mobile phone.

In developing countries about 50% of m-Learning programs are designed to be compliant with feature phone technologies, while smart-phone penetration is still low. This is very important, because access to learning material via mobile phones does not only support formal settings but is often the only chance for informal learning (out of school children, girls looking for anonymous help with questions of HIV prevention etc).

PRESENTATION OF PRELIMINARY IDEAS: THE PROPOSED APPROACH AND THE RESULTS ACHIEVED SO FAR

Delivering education in Sub Sahara Africa (SSA) by using mobile phones is widely seen as an optimal solution, because mobile networks are widely spread. Ford and Leinonen name factors as usability, accessibility, and affordability, to be of most importance (Ford & Leinonen 2009). Those factors need to be taken into account together with appropriate pedagogical models, when developing a model of mobile learning. Many m-Learning projects are currently taking place in SSA, most are on a small scale and often not documented, comparative studies rarely exist (Ho et al., 2009). Most of the projects are not sustainable after the pilot phase, because resources are usually not available to sustain the project on long-term. This has been figured out as one of the challenges of previous projects; an example is the OLPC Project in Ghana (OLPC, 2009). Kukulska-Hulme addressed the importance of socio-technical support for learner mobility (Kukulska-Hulme et al., 2011). Furthermore m-Learning in developing countries is different from the "first world" because of different objectives: due to the fact that formal learning occurs not often, a main focus is on informal learning.

The proposed approach can be structured as following:

- State of the art "m-Learning in developing countries"
- Identifying stakeholders as well as all influenced partners
- Field research in Ghana
- Interpretation of outcomes of interviews, evaluations and observations
- Design of a model for integration of m-Learning in Ghana
- Implementation of m-Learning activities on site, as a follow up of the evaluation,

Mobile technology can enhance the shift from instructional classroom teaching to learner centered educational settings (Holzinger, 2005). It is necessary to point out the difference to institutionalised learning, when designing a model for mobile learning. In traditional formal classroom instruction learners are viewed as objects that hold knowledge that has been pre-determined and pre-planned by the single teacher. In developing countries, due to lack of learning material and textbooks, lessons are mainly teacher-centered, students listen, there is rarely room for creativity, reflection, transformation, critical thinking, interaction and self-directed learning.

Traxler asks: "Do we define m-Learning in terms of technologies, or user experience?" and continues "...knowing where to find the answer becomes more important than knowing it or having it" (Traxler, 2009). Muyinda defines m-Learning as a "process of giving and receiving feedback" (Munyinda, 2007). Munyinda further points out, that a successful m-Learning solution requires a better understanding of the pedagogical, technical and organizational settings in order to develop appropriate solutions. M-Learning allows learners to "choose what, when, where, why, and how they learn in a

way that is individualized, personalized, and highly interactive (Cobcroft et al, 2006). M-Learning can contribute to the quality of education. It offers also opportunities of interaction between teachers and learners.
For the implementation two aspects are important and have to be taken in consideration in the research, based on topics from table 1 (see page 2): Technology and infrastructure, including costs, compatibility and limitations of the device, and management aspects, which include the pedagogical, training and support issues.
Since mobile devices reduce barriers to accessibility, changes in didactics and teacher education are important. Didactical skills for m-Learning are the most important topics and are addressed in the course in Ghana. Testing the platform for science and math education, www.skool.com.gh (which is a joint-project from the Ghanaian government and Intel), and the Ghanaian e-learning portal for kids: http://www.e-learningforkids.org/ allows gathering some experience for later practice in classroom. Www.Skool.com.gh offers various learning sequences aligned to Ghana's new education curriculum. Based on practical work in the course and during the last week in classroom practice, the experience will be evaluated and the outcome integrated in the proposal of the framework for m-Learning in Ghana.

SKETCH OF THE APPLIED RESEARCH METHODOLOGY

Criteria for investigations are: specific educational situation, practical usability, theoretical applicability and viable sustainability in Ghana:

- Scrutinizing literature prior to quantitative and qualitative research:
- Identifying best-practice projects by investigating relevant literature on successful ICT projects in SSA (e.g.: MoMaths [mobile learning for Mathematics Project, developed with Nokia], Mxit, or Mobile4Good [M4G], mobile phone games dealing with health education (HIV);
- Figuring out details: how they contribute to solve specific problems; identifying "gaps" (facts not noted so far);
- Scrutinizing and analyzing evaluation-methods of m-Learning projects, identifying best-practice approaches;
- Transferring the findings to (prospective) work on mobile phones,
- Quantitative research: structured questionnaires, surveys to investigate teachers digital skills and expectations of m-Learning (field research in Ghana)
- Qualitative research: individual interviews (field research, secondary school -teachers, school-authority, telecommunication- networks), group interviews.

Research in the first stage is focussed on teacher education, regarding teachers's kills and curriculum matters. Structured interviews with stakeholders contribute to the findings. Surveys are designed according the topics outlined in Figure 1 (see page 2). An important question stresses content design, which has to be reflected on the findings related to the topics of access and availability. As example to address specific topics the research of Ebner points out trends and behaviour of young people using mobile devices (Ebner, 2102). The overall result is presented in the framework, to indicate the status of readiness for implementation with the teachers of the course.

DESCRIPTION OF THE PH.D. PROJECT'S CONTRIBUTION TO THE PROBLEM SOLUTION

This project should help to provide deeper insights in the different problems and contribute to a better understanding what has to be taken in consideration when planning a sustainable solution for m-Learning. A closer look at the curriculum (information literacy, critical reading and problem solving) will help to figure out challenges in the field of pedagogical awareness and content. In rural areas still exists the problem of delivering qualified education, on the other hand the demand of education is increasing, and has to address the learning needs of young people from poor rural communities. For the youth in rural areas, taking advantage of mobile phone ubiquity, m-Learning is a way to incorporate education into their lives when they may have previously been denied the opportunity. As mobile phones are accessible to communities in remote areas, they also extend the reach of mobile-enabled educational resources (Valk et al., 2010) and open new possibilities for learning.

Learning with mobile phones will increase access to learning material in Ghana in many ways:

- Affordable access to study material (up-to date-information, no printing costs, replacing textbooks, easy to repeat content and instructions, cooperation with peers and in groups, even when not able to attend school)
- Teachers support (access to up-to-date-resources, cooperation with other teachers)
- Motivation for families, learning material is available in the household
- Girls, often not allowed to continue school-attendance, are able to access learning material
- HIV information can be achieved anonymously (important for teenager, girls)

DISCUSSION OF HOW THE SUGGESTED SOLUTION IS DIFFERENT, NEW, OR BETTER AS COMPARED TO EXISTING APPROACHES TO THE PROBLEM

Osiakwan pointed out the importance for young people to use their chance to access online content in the remotest parts of Ghana by using mobile phones, therefore the development of a model for sustainable integration of m-Learning in Ghana is necessary (Osiakwan, 2012). Ghana's experience shows that improvements in access/attending schools put pressure on effectively achieving learning outcomes across various social groups and communities. Completion rate in Ghana is relatively high but not high enough for achieving the Education for All goals (EFA). Geographical inequalities tend to be the most important barriers, closely associated with socioeconomic disparities (EDU 2011). Young people out of socially or locally disadvantaged groups, faced mostly by developing countries, show often no confidence in ICT. Thus, with the implementation of m-Learning at young age could overcome this problem (Saipunidzam, 2010).

Adopting a mobile learning approach can improve the educational quest of Ghana. This project proposes a model for implementation of m-Learning in Ghana. It takes into account the specific technological environment and infrastructure, the needs, choices and expectation of in the region. Integrating teachers already in the first stage, inviting them to contribute with their experience to new didactical and pedagogic strategies, is very important, to motivate them to integrate m-Learning in their daily business in secondary schools. With their activities, m-Learning can help to improving education and the life prospects of young people in Ghana. With a good framework being designed and the support of the stakeholders m-Learning environment could be realized successfully in Ghana.

SUMMARY AND OUTLOOK

In this paper an overview of the current situation in Ghana was given and the opportunity of m-Learning integration in the current educational system outlined. The rapid growth of mobile phone access potentially opens up new ways for addressing the systemic educational challenges in Ghana. Bearing in mind that a holistic sustainable m-Learning model for Ghana has to be developed, the next approach is to integrate the results of field studies. The outcomes of these research studies will be taken into account for further implementations. We assume that learning with mobile phones seems to be an ideal solution to tackle the needs in education in developing countries – on the example of Ghana.

A possible follow up research project: Mobile phones (and today more and more smart-phones) are widely available amongst children in European countries. Due to the fact that these mobile phones are mainly banned from the classroom, it could be a chance, to learn from the experience in Ghana, how the use of these devices might transform the educational practice in secondary schools in the future.

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EXPLANATION OF ABBREVIATIONS:

EFA Education for All, Goals 2015

EFA Goal 6 “Improving all aspects of the quality of education and ensuring excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills”

Feature Phones Low end phones

GPD gross domestic product"

JHS Junior High School

SSA Sub Sahara Africa

OER open educational resources

QR Cache: Connecting mLearning practice with theory

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ABSTRACT

Qatar presents a unique opportunity to explore potential mLearning applications in a theoretical context. The geographically small country in the Arabian Gulf has nearly ubiquitous mobile and wireless network coverage. The penetration of devices such as smartphones is also incredibly high, including amongst students. And those students have expressed an overwhelming desire to integrate their mobile devices into their learning. With its virtual absence of infrastructural barriers, Qatar offers the potential to focus research on how mobile technologies can fulfill the promise of increasing student engagement by creating novel situated learning experiences. QR Cache was developed to provide an exemplar of mobile reusable learning objects (RLOs). In the pilot phase, RLOs accessed by scanning Quick Response (QR) codes were developed to teach English computer terminology. Feedback was solicited from participating students and instructors to demonstrate the desirability of using such RLOs in combination with learners' own mobile devices. The study also draws upon *Transactional Distance Theory* (TDT) (Moore, 1989, 1991) and Koole's (2009) FRAME model to provide theoretical grounding for both RLO and instructional design decisions. Early results show increased engagement, and reduced transactional distance. They also indicate that the RLOs show a strong convergence of the activity types delineated by the FRAME model.

Author Keywords

FRAME, mobile learning, Qatar, QR Codes, reusable learning objects, situated learning, Transactional Distance Theory,

INTRODUCTION

The QR Cache project was developed as a response to stakeholder needs at College of the North Atlantic-Qatar (CNA-Q) and in the State of Qatar. Learners have expressed a desire to see more integration of their own mobile devices (Warraich & Dahlstrom, 2012). CNA-Q has expressed a desire to promote blended learning (CNA-Q, 2011). Employers have expressed a desire to deliver just-in-time, situated learning for both technical and workplace English training. The current infrastructural context allows research to focus on pedagogical elements, as opposed to technical barriers (MacLeod, 2011; Metodieava, 2012; Nagy, 2012; Warraich & Dahlstrom, 2012). The QR Cache project uses a Design-Based Research (DBR) approach to explore the iterative development of mobile RLOs to meet stakeholder needs. TDT (Moore, 1989, 1991) and Koole's (2009) FRAME model are used to guide the RLO design process, and to evaluate their pedagogical effectiveness.

The first phase involved the development of a set of mobile RLOs to be used by English Foreign Language (EFL) students enrolled in CNA-Q's Technical Preparatory Program (TPP). The RLOs were accessed by scanning Quick Response (QR) codes, and were used to learn English computer hardware terminology. Participants have shown a positive response to the situated strategy. It is hoped that future iterations will lead to increased adoption of mobile RLOs by college instructors and in the Qatari workplace, as well as to the development of a comprehensive mLearning strategy at CNA-Q. It is also hoped that future iterations will lead to an increased understanding of how mobile RLOs can improve student engagement and learning by reducing transactional distance and increasing activity between students, content, their peers, and technology itself. Lessons learned from this, and future iterations of the QR Cache project will be used to help develop a practical mobile RLO design checklist, grounded in applicable learning theory, that can guide instructors in the development of effective mLearning activities and resources.

RESEARCH QUESTIONS

The specific research questions explored in the first phase of the QR Cache project are:

1. How do learners respond to the use of mobile RLOs, accessed by scanning QR codes, to learn English computer terminology and concepts?
    a. Do learners experience any difficulties when accessing the RLOs?
    b. Do learners enjoy using such mobile RLOs?
    c. Would learners like to use such RLOs more often?
2. Does the integration of the mobile RLOs, accessed by scanning QR codes, reflect the principles and benefits of effective mLearning design?

a. Do the RLOs help to reduce transactional distance between learners and content, learners and other learners, or learners and teachers (Moore, 1989, 1991)?

b. Do the RLOs create optimal interaction between individuals, technology, and social elements, as outlined by the FRAME model (Koole, 2009)?

LITERATURE REVIEW

The QR Cache research project is grounded by work that has contributed to an understanding of how learners interact in technology-mediated learning situations (Moore, 1989, 1991), how multimedia elements impact teaching and learning (Clark, 1994a, 1994b; Hastings & Tracey, 2005; Joy & Garcia, 2000; Kozma, 1994a, 1994b), and what should be considered when designing effective mLearning experiences (Bradley et al., 2009; Elias, 2010; Fitzgerald, 2012; Koole, 2009; Naismith & Smith, 2009; Traxler & Wishart, 2011). These works have shaped an understanding of what an effective mLearning RLO should look like.

Moore's *Transactional Distance Theory* (TDT) (1989, 1991) has been central in much of distance education and mLearning research. TDT views learning as an attempt to reduce physical and mental distance between the learner and the instructor, the content, and other learners. Koole's FRAME model (2009) builds upon TDT, as well as Vygotsky's *zone of proximal development*, in an mLearning context (p. 37). It presents a framework for designing and evaluating mLearning by maximizing key elements, and by reducing the gap between "what the learner is currently able to do and what she could potentially do with assistance from more advanced peers (p. 37)". The reduction of transactional distance through situated learning is a central aim of the QR Cache research project. Koole's FRAME model is used to examine how effectively the RLOs create such a learning scenario (p. 41).

In light of understandings of TDT and media effectiveness, recent work has focused on providing practical advice for instructional design using mobile technology (Beddall-Hill, 2011; Bradley et al., 2009; Elias, 2010; Fitzgerald, 2012; Koole, 2009; Naismith & Smith, 2009; Traxler & Wishart, 2011). Koole's FRAME model (2009) illustrates how learners, social interaction, and mobile technologies intersect to create optimal mLearning scenarios. Elias (2010) and Traxler and Wishart (2011) provide checklists for the effective design of mLearning. Bradley et al. (2009) and Naismith and Smith (2009) provide case studies of how mLearning RLOs should be designed to meet the needs of specific groups of learners. Similarly, Fitzgerald (2012) explores standards for creating mLearning applications with effective interaction and the production of meaningful RLOs. These works provided the bases for the development of the RLOs for the QR Cache project, and are used to provide theoretical grounding in the analysis of the effectiveness of the mobile RLOs.

METHODOLOGY

RLO Design Methodology

The QR Cache project involved the development of a set of mobile RLOs for use in a specific course. Each RLO is designed to be completed in less than five minutes. Students use an app on their own devices to scan QR codes mounted on computer devices. This redirects their mobiles to the online RLOs (Educause, 2009; Ramsden, 2008). The RLOs use a linear progression strategy (Bradley et al., 2009), and contain a combination of graphics and text (to provide pronunciation guidance, and brief functional descriptions of the related computer hardware component(s)). At the end of each RLO, students can access a survey designed to "Test Your Knowledge" of the topic. The surveys are incorporated to provide formative feedback, and to spark discussion amongst students and their instructors.

Research Methodology

For the first phase, the mobile RLOs were used to replace workbook-based learning for a computer hardware components unit in the TPP Introduction to Computers course. A primer lesson was integrated to teach students about QR codes, and provide them with an opportunity to explore the QR code scanning capabilities of their mobile devices. When necessary, instructors and students worked together to locate and install QR code scanning applications. The next two class sessions were used to explore samples of computer hardware components to which QR codes had been mounted. Students were responsible for learning the English terminology and basic functions of the devices.

Upon completion of the in-class activities, participating students were invited to complete on online questionnaire about their learning experiences using the QR codes and their own mobile devices. The questionnaires consisted of a combination of fixed and open-response items (Cohen et al., 2011, p.382) covering such themes as ease of access, the look and feel of the RLOs, levels of interaction with their peers and instructor, and overall impressions. A similar questionnaire was prepared for participating instructors to provide feedback on the learning activities and RLO designs. Responses to fixed and open-response questionnaire items were coded to reflect the research issues (p. 559-563). These were analyzed for the identification of major themes related to student and instructor perceptions, and evidence of effects upon transactional distance and the types of activities that form the domains of the FRAME model.

RESULTS

A total of seven students and two instructors completed questionnaires during the first phase. Responses to demographic questions about mobile device ownership were consistent with previously reported figures for CNA-Q, Education City, and the State of Qatar (MacLeod, 2011; Metodieava, 2012; Nagy, 2012; Warraich & Dahlstrom, 2012). All of the students owned smartphones. Four students reported owning two devices, and one student reported owning three (or more). Only two students had a QR code scanning app installed on their devices prior to the study. The remaining respondents were able to download a free app without any reported difficulty. Four students had previously scanned QR codes to access websites, while only one reported previously accessing text-based content, and one reported previously using a QR code to automatically dial a phone number.

All of the students indicated that scanning the QR codes was either easy or very easy and that the RLOs loaded quickly on their devices. Only one student reported that an RLO did not load properly. All of the students responded that it was easy to view the text and images, and the RLOs were easy to navigate. Six students indicated that it was either easy or moderately easy to understand the content, and to complete the "Test Your Knowledge" feedback questions at the end of each RLO. One student indicated that the RLOs contained too much information, and that the "Test Your Knowledge" activities were difficult to complete.

With respect to interaction with technology, content, peers and instructors, six out of seven student respondents indicated that they shared their mobile devices with another classmate while participating in the RLO activities. Five students and both teachers indicated that they discussed the mobile RLOs during the class activities, and four students indicated that they engaged in discussions of the "Test Your Knowledge" activities. All seven students indicated that they viewed the RLOs more than once, and five indicated that they showed the RLOs to friends outside of the class.

Students and teachers generally indicated that they found the use of the RLOs, and their own mobile devices, appealing. Five of the seven students responded that they found these types of learning activities appealing, while one reported a neutral opinion, and one indicated that they found it somewhat unappealing. Only two of the seven students reported having ever used a mobile device for formal learning before, but all of the respondents indicated that they would like to do so again either at school or while on the job. When asked what they liked about using QR code scanners and their own mobile devices to access RLOs, students commented on the speed and ease of accessing the learning materials. As one student commented, "it's very easy to scan and find the page that you want."

DISCUSSION

The results of the first iteration of the QR Cache project show trends in mobile device ownership and the desire to use mobile devices in formal and informal learning similar to those previously reported in Qatar (MacLeod, 2011; Metodieava, 2012; Nagy, 2012; Warraich & Dahlstrom, 2012). Students and teachers reported enjoying learning with their mobile devices, and found the RLOs easy to access and use. Students indicated that they would like to use their mobile devices for learning more often. These results provide a degree of justification to pursue further investigations into integrating mLearning strategies at CNA-Q. But a stronger justification can be provided by grounding these findings in learning theories that explain how the mobile RLO approach creates an effective learning experience.

TDT (Moore, 1989, 1991) and the FRAME model (Koole, 2009) provide useful and complimentary lenses for examining the effectiveness of the QR Cache RLOs. Student and teacher responses show a reduction in transactional distance between learners and the content. The content is easy to access and re-access, and it is situated so that it is easier for learners to contextualize the topics. Learner-learner and learner-teacher transactional distance also appear to have been reduced. Data indicate that students interacted with each other and their instructors while participating in the learning activities. The results also indicate that the RLOs generated appropriate activity across the domains of the FRAME model. Student and teacher survey responses indicate a high degree of device usability. They also show that learners are actively engaged in social interaction during the learning activities, and that the use of their mobile devices facilitated that interaction by creating a shared situated learning experience, and by generating both formal and informal social discussion. Beyond creating an enjoyable and easily accessible learning experience, TDT and the FRAME model illustrate how the use of the mobile RLOs positively affect the learning that is taking place.

There are limitations which must be considered when interpreting the findings of this research (Cohen et al., 2011). The online questionnaire was the only method of soliciting feedback used in the first phase. The survey schedule would benefit from an in-depth piloting and refinement phase. The addition of either one-on-one or focus group interviews would provide further opportunity to solicit qualitative feedback, and to triangulate the findings with respect to learner perceptions (pp. 382, 412-417). Data on student achievement on two standardized assessment instruments was collected during the first phase, for comparison with a control class of learners who did not use the mobile RLOs. While all learners demonstrated mastery of the required competencies, the sample size was too small to obtain confidence in the results of statistical analyses of the achievement data (p. 144). The refinement of the online questionnaire and development of interview scripts could be carried out before the implementation of a second DBR phase. A second DBR iteration of the QR Cache project would greatly benefit from their integration, as well as from the statistical analysis of standardized assessment results across a larger sample of the student population.

CONCLUSIONS

While the first phase of the QR Cache project was a small-scale pilot of the mobile RLOs designed for the TPP MC-105 Hardware Components unit, the results do hold promise for future research and understanding of the effectiveness of situated mLearning approaches. Future iterations of the DBR project are needed to verify the findings with larger samples, and to provide further RLO exemplars for instructors at CNA-Q. Further research is also needed to more deeply explore the ability of such RLOs to reduce levels of transactional distance, and to create an optimal convergence of learner, device and social interaction activities. Such research holds promise for moving beyond merely exploring the utility of mLearning strategies, and moving into their justification through connection to established learning theory.

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