MOBILE LEARNING 2013

Lisbon, Portugal | 14 - 16 March

PROCEEDINGS

Edited by:
Inmaculada Arnedillo Sánchez
Pedro Isaías

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INTERNATIONAL CONFERENCE

MOBILE LEARNING 2013

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE MOBILE LEARNING 2013

LISBON, PORTUGAL

MARCH 14-16, 2013

Organised by
IADIS
International Association for Development of the Information Society

Edited by Inmaculada Arnedillo Sánchez and Pedro Isaías

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FOREWORD

These proceedings contain the papers of the International Conference on Mobile Learning 2013, which was organised by the International Association for Development of the Information Society, in Lisbon, Portugal, March 14 – 16, 2013.

The Mobile Learning 2013 International Conference seeks to provide a forum for the presentation and discussion of mobile learning research which illustrate developments in the field. In particular, but not exclusively, we aim to explore the theme of mobile learning under the following topics:

- Learning analytics and mobile learning
- Cloud computing and mobile learning
- Pedagogical approaches, models and theories for mLearning
- mLearning in and across formal and informal settings
- Strategies and challenges for integrating mLearning in broader educational scenarios
- User Studies in mLearning
- Learner mobility and transitions afforded by mlearning
- Socio-cultural context and implications of mLearning
- Mobile social media and user generated content
- Enabling mLearning technologies, applications and uses
- Evaluation and assessment of mLearning
- Research methods, ethics and implementation of mLearning
- Innovative mLearning approaches
- Tools, technologies and platforms for mLearning
- mlearning: where to next and how?

The Mobile Learning Conference 2013 received 116 submissions from more than 28 countries. Each submission has been anonymously reviewed by an average of 4 independent reviewers, to ensure that accepted submissions were of a high standard. Consequently only 17 full papers were approved which means an acceptance rate of 15%. A few more papers were accepted as short papers, reflection papers, posters and doctoral papers. An extended version of the best papers will be published in the International Journal of Mobile and Blended Learning (ISSN: 1941-8647).

The Conference, besides the presentation of full papers, short papers, reflection papers, posters and doctoral papers also included a keynote presentation from an internationally distinguished researcher. We would therefore like to express our gratitude to Professor Frans Mäyrä, INFIM/TRIM/Game Research Lab & School of Information Sciences, University of Tampere, Finland, for accepting our invitation as keynote speaker. Also a special thanks to Cathie Norris, Regents Professor, University of North Texas, Denton, TX. USA and Elliot Soloway, Arthur F. Thurnau Professor, University of Michigan, Ann Arbor, MI, USA for being our invited speakers and also for presenting a tutorial.

A successful conference requires the effort of many individuals. We would like to thank the members of the Program Committee for their hard work in reviewing and selecting the papers that appear in this book. We are especially grateful to the authors who submitted their papers to this conference and to the presenters who provided the substance of the meeting. We wish to thank all members of our organizing committee.

Last but not least, we hope that everybody has enjoyed Lisbon and their time with colleagues from all over the world, and we invite you all to next edition of the International Conference Mobile Learning in 2014.

Inmaculada Arnedillo Sánchez, Trinity College Dublin, Ireland.
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Lisbon, Portugal
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KEYNOTE LECTURE

FROM MOBILE GAMES TO PLAYFUL COMMUNICATION: PLAY IN EVERYDAY LIFE

By Professor Frans Mäyrä
INFIM/TRIM/Game Research Lab & School of Information Sciences,
University of Tampere, Finland

Abstract

Especially for the younger generations games are the most important form of media in their lives. According to the recent Player Barometer study, in Finland already 56 % of population (ages 10-75 years of age) are active players of digital games, and the number is rising. The average game player age is 37 years. However, the intensity and forms of play vary much in different demographic groups. It is important to be aware of forms of play and playfulness that are not restricted to the game play in immersive computer and video games. Mobile games are a typical example of small, “casual games” that attract also players who do not typically self-identify as “gamers”,and yet are interested to have some kinds of games and play as parts of their everyday life. As the influence of mobile devices and online, connected services increases, there will be both positive opportunities for new, innovative types of games and play, but also an increasing danger of cognitive stress and information overload. This keynote will address the role of “playfulness”in games and (non-game) online media services, and probe into “playful communication” as an important element for the future of information and media literacy.

INVITED TALK

USING MOBILE DEVICES AS ESSENTIAL TOOLS FOR LEARNING IN PRIMARY & SECONDARY SCHOOL

by Cathie Norris, Regents Professor, University of North Texas, Denton, TX. USA and by Elliot Soloway, Arthur F. Thurnau Professor, University of Michigan, Ann Arbor, MI, USA

Abstract

The data suggest that when computing devices are used as essential tools for learning, then – and only then – are increases in student performance observed. By "essential use" we mean used for 50%-70% of the school day – and outside of school – using a variety of productivity tools (e.g., writing, concept mapping, drawing/animating, etc.) and domain specific tools (e.g., science visualization) as well as the Internet. By and large, however, shared computing devices are used in classrooms as supplements, as add-ons, to curriculum. As the cost of Internet-connected mobile devices continues to plummet, it will become commonplace for a student to bring his/her mobile computing device to school. To leverage those "BYOD" – Bring Your Own Device – devices and have them used as essential, not just supplemental to the curriculum, students need more than a few apps. Towards creating the "Linux for educational technology" we have built and are distributing free the WeLearn Mobile Platform that runs on iOS and Android mobile devices. In our presentation, we will report on the use of WeLearn in classrooms in Singapore and the U.S. Finally, computing devices, used as essential tools, will have a significant impact on student performance!

CONFERENCE TUTORIAL

EXPLOITING THE WELEARN MOBILE PLATFORM TO SCAFFOLD SYNCHRONOUS COLLABORATION

by Cathie Norris, Regents Professor, University of North Texas, Denton, TX. USA and by Elliot Soloway, Arthur F. Thurnau Professor, University of Michigan, Ann Arbor, MI, USA

Abstract

In our hands-on tutorial, we will demonstrate how the WeLearn Mobile Platform – a free resource that supports interoperation between iOS and Android devices – can scaffold educators and students in developing and using collaborative learning skills. WeLearn is an end-to-end system, with productivity apps running natively on client devices (e.g., smartphones, tablets) and a Learning Management System on the backend that enables students to sync their artifacts to a teacher-accessible, cloud-based portal.

Attendees will gain first-hand experience with WeLearn and are welcome to use WeLearn in their classrooms.

Full Papers

COMMON MOBILE LEARNING CHARACTERISTICS-AN ANALYSIS OF MOBILE LEARNING MODELS AND FRAMEWORKS

Umera Imtinan, Vanessa Chang and Tomayess Issa
School of Information Systems, Curtin University, Perth, Australia

ABSTRACT

Mobile learning offers learning opportunities to learners without the limitations of time and space. Mobile learning has introduced a number of flexible options to the learners across disciplines and at different educational levels. However, designing mobile learning content is an equally challenging task for the instructional designers. Currently, mobile learning researchers are trying to determine a set of mobile learning characteristics to inform mobile learning design. Besides conforming to the pedagogical requirements, mobile learning instructional designers are also considering the nature of learning activities to engage learners with miniature mobile devices. Similarly, there are a number of mobile learning characteristics which are crucial to mobile learning design in order to harness the power and affordances of mobile devices as well as maintaining the learning element as the main focus. This paper is an attempt to point out common mobile learning characteristics as they appear in key mobile learning conceptualizations, models and frameworks in the literature. These characteristics may be useful for future researchers to inform the mobile learning design process as well as mobile learning conceptualizations.

KEYWORDS

Mobile learning characteristics, Mobile learning design criteria, Usability, Collaboration, Mobility, Mobile learning models and frameworks

1. INTRODUCTION

Mobile learning enables learners to learn anywhere and at any time using mobile technologies (Vosloo, 2012). In order to understand what mobile learning truly offers to the learning environments, a detailed argument is needed more than just a cohort of definitions. In this paper, the key characteristics of mobile learning reflecting the benefits and challenges in this field are discussed. For the purpose of finding the most influential and significant mobile learning characteristics reported by the mobile learning researchers, we have examined a variety of research papers in the research literature of mobile learning; including but not limited to the mobile learning research reports, projects, pilot studies, trials, implementations, conceptualizations, theories, models and frameworks. However, the scope of this review is limited to the studies focusing on mobile learning conceptualizations, models and frameworks in order to identify common and popular mobile learning characteristics. Usability, collaboration, context, content, control (authenticity/administrative checks and teacher's control on learning process), blending with other forms of learning, connectivity (sometimes referred as network access or coverage) and mobility (referred as flexibility and portability interchangeably) have been identified in literature as the key characteristics of mobile learning ((Danaher et al., 2009, Parsons and Ryu, 2009, Frohberg et al., 2009, Chao et al., 2009, Koole, 2009, Denk et al., 2007, Barker et al., 2005, Naismith et al., 2004a). However, all of these characteristics have not been collectively identified in a single research study. Most of the studies focus on only a limited number of mobile learning characteristics. This paper attempts to address this gap; based on the literature review, the researchers have suggested a set of common mobile learning characteristics to be considered for mobile learning instructional design as well as future mobile learning conceptualizations.

2. RESEARCHING MOBILE LEARNING CHARACTERISTICS

For the purpose of researching and identifying set of common mobile learning characteristics, mobile learning conceptualizations, models and frameworks will be discussed in this review. A number of scholarly sources were examined including Science Direct, ACM Digital Library, Proquest (ABI-INFORM) and SpringerLink. Further, the researchers manually consulted several journals that regularly publish mobile learning research. These journals include: International Journal of Mobile Learning and Organizations, International Journal of Mobile and Blended Learning, Computers and Education, Journal of Computer Assisted Learning and British Journal of Educational Technology. Since there are relatively few research articles that focus in particular on the conceptualization of mobile learning, the proceedings of a few popular conferences such as the MLearn series and IADIS Mobile Learning conferences were also examined.

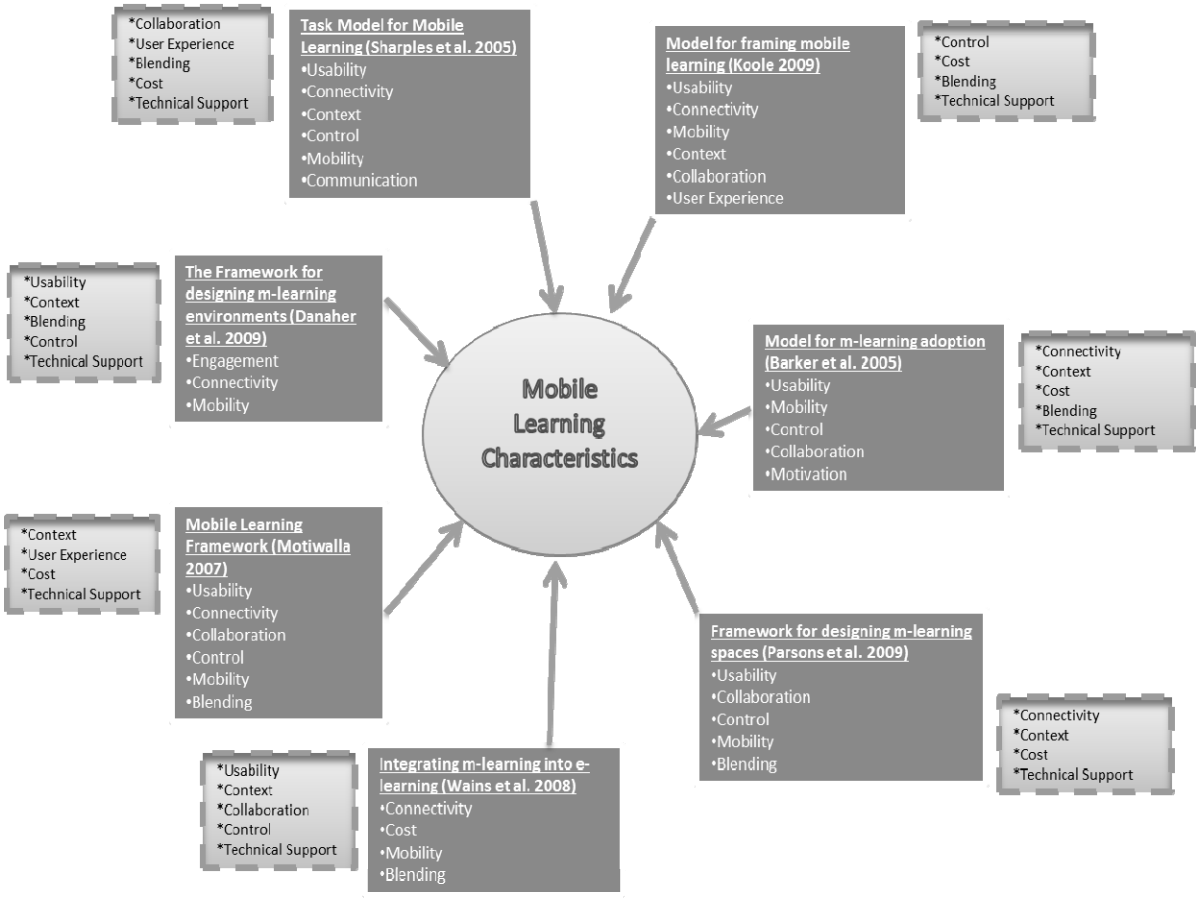

Figure 1. Mobile Learning Characteristics - Literature Snapshot

The above mentioned literature sources from 2005 to 2012 were scanned for the terms “mobile learning models and frameworks” and “mobile learning conceptualization”. The initial search yielded around 700 articles using these keywords. Further, a filter term “mobile learning characteristics” was applied; however, it did not yield significant results.

The researchers realized that not every mobile learning researcher used this terminology to classify mobile learning characteristics in their discussion of models and frameworks. Therefore, the researchers decided to examine the resultant articles manually to look for the mobile learning characteristics; these were narrowed down to 19 studies matching the purpose of the review. Mobile learning researchers have discussed mobile learning characteristics in a number of studies; however, most of the studies found in the literature so far did not provide a comprehensive list of mobile learning characteristics in a single research setting.

As shown in Figure 1, the researchers have presented a snapshot of the mobile learning characteristics discussed and not discussed in the most-cited mobile learning studies in the literature, using some of the selected studies to explain how the researchers have analyzed and compared each study for mobile learning characteristics. In Figure 1, the inner rectangles show the main mobile learning characteristics considered in that study; the outer rectangles contain the characteristics which have not been considered in that particular study. Regarding mobile learning characteristics, the findings from the literature showed that most of the studies have focused on a particular set of mobile learning characteristics such as usability, collaboration, flexibility and connectivity (See Figure 1). Some of the characteristics such as context, control, engagement and blending mobile learning with other forms of learning have been used by only a few of the mobile learning researchers while other mobile learning characteristics such as user experience, motivation, technical support and cost have rarely been included and accumulated in most of the mobile learning models and frameworks. This paper compiles the set of common mobile learning characteristics including all of these characteristics mentioned in the extant mobile learning literature. It is also important to point out that different studies may have used different terminology for the same characteristics. For example, 'mobility' and 'flexibility' have been used interchangeably in many studies; the same goes for 'connectivity' and 'network access point' in the same context (Frohberg et al., 2009, Koole 2009). Therefore, the researchers grouped similar characteristics the one name predominantly used in the literature to represent each character or concept and used it in subsequent sections in this paper in order to maintain consistency and avoid confusion for the reader. The next section presents a detailed account of the common mobile learning characteristics as determined in this paper.

3. COMMON MOBILE LEARNING CHARACTERISTICS

Current mobile learning literature shows that mobile learning researchers have been experimenting on a number of mobile learning characteristics. After the rigorous process of scanning and reviewing literature, the researchers have concluded that usability, collaboration, context, control, connectivity, mobility, content, blending, technical support and cost are the common mobile learning characteristics. It appears from the literature that these characteristics have been incorporated and researched in most of the mobile learning studies dealing with the subject so far. The following sub-sections discuss each of these common mobile learning characteristics in detail.

3.1 Usability

Usability relates to the ease of using mobile devices for learning purposes in respect to screen size, battery life, size, weight, memory, processing power, compatible applications and user interface (Koole, 2009, Kukulska-Hulme, 2005b). Other than these basic usability issues, Koole (2009) includes a number of other factors such as aesthetic appeal of the device, simplified display, fewer steps required to perform a task, ease of navigation, customization options and environment or climate of the place where the learner is located. Besides the usability features of mobile devices, Kuen (2006) provides a usability guidelines framework for designing mobile learning portals which focuses on analyzing the learner's usage skills, human-mobile interaction and interface design as main categories to develop usability guidelines for designing mobile learning portals containing mobile learning content and applications. Bearing in mind the fact that current mobile devices, and the ones used in previous pilot projects such as PDAs and smart phones, are not built for learning purposes, it is more likely that learners will face usability problems. Therefore, researchers such as Kuen (2006) recommended guidelines for designers of mobile learning portals. However, as the mobile devices are becoming multi-purpose and more sophisticated in design and functionality, the basic usability problems such as battery life, memory capabilities and screen size limitations, will diminish (Wu et al., 2012, Ambient-Insight's, 2008).

3.2 Collaboration

Collaboration demonstrates the level of communication and interaction between the learner and the teacher as well as among other learners (Parsons and Ryu, 2009). A number of studies around the world have shown

that mobile learning will make learning processes more informal and collaborative (Mifsud, 2002). Collaboration in learning has been proven to enhance learning outcomes. Parsons et al. (2009) argue that collaborative learning gives better understanding of the subject matter to all contributors or group members and this in itself is a good reason for accepting mobile technologies in learning environments. Palfrey et al. (2008, 248) relate mobile technologies to collaborative learning because the former can be utilized the best in order to reap the benefits of "team-based learning". Spikol et al. (2009, 174) refer to Piagetian theories of collaborative learning based on "conversations that can result in cognitive restructuring" and Vygotskian views about "peer-to-peer interaction" which facilitate knowledge sharing and knowledge creation. Mobile learning encourages collaboration among learners, teachers and other stakeholders in learning environments (Barker et al., 2005). A number of mobile learning projects have been implemented around the world showing improved learning outcomes by students when engaged in a range of collaborative activities including field work, group projects and classroom activities. Furthermore, most mobile learning theorists in the current literature have included collaboration or collaborative learning activities as one of the driving factors in the adoption and/or acceptance of mobile learning by education providers at the elementary school level, college level or university level (Danaher et al., 2009, Ford and Leinonen, 2009, Motiwalla, 2007).

3.3 Context

Context refers to the physical environment of the learner or where the learning takes place (Frohberg et al., 2009). Mobile learning presents learners with a variety of contexts where they can learn and experiment in real-world situations (Geddes, 2004). Learners can interact with the environment and make sense of the objects with location awareness of mobile devices such as museum tours; an example is the Tate modern Multimedia tour pilot project and MobiLearn project where learners experienced contextualized learning using mobile devices during the tour that provide information about objects on display (Proctor and Burton, 2003, Bormida et al., 2002). A study by Chen et al. (2003) reporting on the observation of birds on a farm is another example of context in the mobile environment where students, on a field trip, learn about birds by observing the physical activities of birds and use mobile devices to record information and identify objects. The context of the learner can be a classroom or any other controlled learning environment such as a mobile learning study conducted by (Lowery, 2005) where a teacher uses a quiz in the classroom and relies on responses from the students to proceed with the learning session. Spikol et al. (2009, 174) discuss context in relation to collaboration for mobile learning and define context as "information and content in use to support a specific activity (being individual or collaborative) in a particular physical environment". In mobile learning, the context of the learner is a key construct as mobile devices allow the learner to access, navigate and make sense of information where and when it is needed.

3.4 Control

Control refers to the amount of grip a teacher or a learner has on the learning process for smooth continuity and best outcomes (Frohberg et al., 2009). When designing mobile learning environments, it is very important to emphasize the role of the moderator who mediates the learning process, controls it to a certain extent and creates the learning environment which nourishes learners with guided reflection; otherwise, learners may be at risk of losing direction (Sharples et al., 2005). As a theoretical foundation for their mobile learning research, Harrington et al. (2009) discuss the concept of authentic learning where students are able to resolve real-time complex problems in professional environments and by reflection create new knowledge, at times guided by teachers. The teacher's role and intervention in the learning process is of vital importance. Pachler et al. (2010, 160) refer to "the conversational framework for supporting the formal learning process" suggested by Laurillard (2007, 160) which shows the notion of "the world of experience" for the role of teacher in the learning process; they present a further critical analysis of the conversational framework.

"Learning is viewed as a series of iterative conversations with the external world and its artifacts, with oneself, with other learners and, of course, teachers". Frohberg et al. (2009, 317) have categorized mobile learning projects (published up to 2007) from a fully teacher-controlled learning scenario to a fully learner-controlled learning scenario and recommend scaffolding as an optimized option in the middle of the two extremes; their reasons for scaffolding recommendations include:

1. Learners are from a variety of backgrounds and have distinct learning needs.

2. Different phases of the learning process may vary in terms of need for scaffolding.
3. Scaffolding may be very appropriate for individual learning and team-based learning.
4. Learners may encounter unexpected problems or opportunities and may need to take the initiative when making decisions by themselves at times.

In mobile learning environments, it is quite crucial to decide how autonomous a learner should be so that the best learning outcomes can be achieved; therefore, it is important to consider the level of control when designing mobile learning environments.

3.5 Connectivity

Connectivity, in respect of mobile technologies, refers to how mobile devices can connect wirelessly using a variety of cellular and wireless access technologies such as GPS, EDGE, GPRS, GSM, 3Gs, 4Gs, WiMAX, WiFI, WLAN (Roschelle, 2005, Ambient-Insight's, 2008). Mobile connectivity includes voice telephony and internet access for data transmission. Connectivity, as a mobile learning characteristic, relates to how effectively a learner can access the required information or learning material on a mobile device (Koole, 2009). Network access technologies work as an interface between users, mobile devices and learning resources. Learning resources may be accessible through a wide range of mobile technologies and devices. In the mobile learning arena, a few researchers have used the term 'accessibility' for network access capabilities and access technologies; however, accessibility is generally referred to in relation to the provision of proper facilities for the people with disabilities (Rainger, 2005). Connectivity enables mobile learning to be more ubiquitous and portable (Traxler, 2005). As the network coverage continues to expand and develop better quality, more learners are likely to be attracted to mobile learning. Traxler (2005) also differentiates mobile learning from e-learning on the basis of connectivity and presence as he posits that mobile learning provides more opportunities for the learners to discover the knowledge-world in unique ways, which makes it distinct from e-learning and other forms of technology mediated learning.

3.6 Mobility

Mobility is sometimes used as an interchangeable term with flexibility and portability (Koole 2009). It is the ease of accessing learning material and collaborating with peers regardless of time and space (Kukulska-Hulme, 2005a). Mobility is one of the key constructs in the design of mobile learning systems and environments because mobility is, as noted by Sharples et al. (2002), a shared attribute of mobile devices and the conceptions of learning; students learn in different places and different times when mobile devices support them to learn anywhere-anytime (Pachler et al. 2012). Naismith et al. (2004, 4) define mobility as "the ability to link to activities in the outside world also provides students with the capability to 'escape' the classroom and engage in activities that do not correspond with either the teacher's agenda or the curriculum". Koole (2009) has used the term *portability*, meaning mobility, which allows mobile devices to be taken to different locations and environments and even to remote places. Subject to mobility characteristics, mobile learning is called spontaneous, contextual, on-demand, flexible, just-in-time, situated, portable and mobile (Traxler, 2009). Brown (2009) points out that mobility is becoming a way of life as it has made most mobile users keen to access resources and turned them into implicit learners. Further, Brown (2009) recommends that the mobility of the devices should be exploited to enrich the learning experience for learners.

3.7 Blending

Blended learning is a ubiquitous learning solution which combines the benefits of various learning domains such as mobile learning, e-learning, face-to-face learning and contextual learning (Chao and Chen, 2009, Peter, 2007). Ally (2009) defines blended learning as a variety of learning approaches with virtual and physical learning resources combined appropriately. Accessing learning content on mobile devices is advancement in the blended learning arena as it takes the learning experience to be lifelong and informal (Pieri and Diamantini, 2009). Wan and Howard (2007, 187) mention that the ubiquity of mobile devices enables blended learning in terms of resources available on mobile devices and a number of learning activities that a learner can perform such as "concept-mapping, organization, note-taking, writing, researching, reading e-documents, doing worksheets and submitting them for checking, watching animations

and movies, drawing graphs, calculating mathematical problems, data collecting, doing their homework, keeping a reflective log, undertaking recording (voice and stylus) and interacting with simulations and multimedia educational materials. Having access to a hand-held all the time is like having all in one access to the pens, text books or other written resources, cameras, calculators, voice recorders, clocks and Internet." Naismith et al. (2004) also consider that adapting the blended approach to mobile learning is imperative because of its orientation with multiple theoretical and practical perspectives. Literature shows that mobile learning, when blended with other forms of learning, makes the learning experience more fruitful, rigorous and collaborative. Mobile learning provides an opportunity to support and enhance performance of learners and engage them in learning activities. To include mobile learning in mainstream education, blending it with existing learning forms such as face-to-face learning and e-learning is the rational solution for education providers.

3.8 Content

Mobile learning content refers to the learning resources for students in a format compatible with mobile devices (Frohberg et al., 2009). Low (2007) has formulated a set of mobile learning standards in the Australian Flexible Learning Framework for creating, adapting, accessing and modifying learning content or learning material for mobile devices. Mobile learning content development depends on what kinds of learning activities are required for a specific learning scenario. The literature suggests a range of mobile learning activities such as accessing information remotely, file sharing, taking photos, recording and playing audio and video files and sharing these files remotely and creating collaborative content online (Parsons and Ryu, 2009, Naismith et al., 2004b). Traxler (2005, 264) in his definition of mobile learning, calls it "spontaneous, informal, bite-sized, light-weight, context aware, connected, personalized, interactive"; these terms indicate the type of content suitable for mobile learning. Mobile learning content can be custom built by education providers following individual institutional preferences; however, packaged content (usually called mobile learning applications or apps, as activities, are translated to apps by software developers) is also available in the market (Ambient-Insight's, 2008, Parsons et al., 2006).

3.9 IT or Technical Support

Making mobile learning a seamless learning opportunity is not possible without technical support for teachers and students. Chen et al. (2010) suggest that the lack of appropriate technical and administrative support is one of the biggest factors influencing teachers' adoption of mobile learning. In particular, if teachers are digital immigrants and have to redesign courses for mobile learning, they would need quite a lot support to make the content bite-sized. More than the instructional design support, they would require technical support if they face any problems with uploading and maintaining mobile learning content (Chen et al., 2010, Prensky, 2009). Similarly, if students face any difficulties in accessing and downloading learning resources, technical support would be an immediate need. Literature shows that mobile learning implementation at different educational levels such as schools, colleges and universities required extensive IT or technical support to make the mobile learning implementation successful and reliable (Ford and Leinonen, 2009, Motiwalla, 2007).

3.10 Cost

Mobile learning design and implementation produce heavy costs for institutions, and learners may also need to pay for the mobile data usage. Dyson et al. (2009) point out that the cost of mobile learning adoption is a considerable hindrance for many education providers. The cost of mobile technologies for learning has been divided into four main categories by Dyson et al. (2009). Costs are incurred by the education providers and the students in various areas including usage charges, mobile hardware costs, mobile software costs and costs of networks utilized by education providers.

Usage charges refer to the telecom providers' bills for the data usage; these charges are billed to the learners directly and most of the education providers are not willing to approve any grants to cover the usage charges. These charges are quite high and expensive for students even in many developed countries (Scornavacca et al., 2009). Dyson et al. (2009) suggest that students may avoid extensive data charges by

downloading learning material on a PC and transferring it to a mobile device and they would prefer to use WI-Fi networks provided by institutions free of cost; however, avoiding costs for data usage may restrict them to using a number of opportunities provided by mobile learning on the move and outside the institutional premises. The price for purchasing a mobile device for learning is also quite high, but education providers often have funding to purchase mobile devices for research purposes. Interestingly, Economides and Grousopoulou (2009) found that students are willing to purchase even an expensive mobile device with advanced features. Similarly, Lundin et al. (2010) propose that education providers should exploit the students' personal devices for educational uses as they bring them to institutions and already use them for communication and social networking.

4. FUTURE RESEARCH

Most of these characteristics have been discussed in mobile learning conceptualizations and theorizations and been researched through projects, trials and implementations of mobile learning. However, there are a number of mobile learning characteristics which are important but yet to be explored such as the cost associated with mobile learning implementation on the part of all stakeholders involved, how motivated the learners and teachers are in terms of initiating mobile learning in higher education, the impacts of the social and cultural backgrounds of the stakeholders on the success of mobile learning implementations (Pachler et al., 2012, Dyson et al., 2009, Barker et al., 2005). In addition, there is great research potential in investigating the mobile learning characteristics of under-served populations and developing nations and determining whether mobile learning is a convenient and affordable learning option (Traxler, 2009). These are possible future research directions which can extend the current set of common mobile learning characteristics presented in this paper. Currently, a research project is being carried out by the researchers of this paper to investigate mobile learning characteristics of a particular developing country as the first author's PhD research focus. This project involves students, teachers and administrative stakeholders in the higher education sector in an investigation of mobile learning characteristics of developing countries. The review of mobile learning characteristics in extant mobile learning research literature assisted the researchers to build a mobile learning conceptual model for Pakistan to investigate the mobile learning characteristics appropriate for Pakistani university environments in particular and for developing countries in general. The researchers will release a mobile learning conceptual model based on the mobile learning characteristics after the research results have been compiled. However, an initial mobile learning model was developed and published in 2010 (Imtinan et al., 2010).

5. CONCLUSION

In order to include mobile learning in mainstream education, mobile learning design needs to be informed by certain criteria. The criteria for mobile learning design should include mobile learning characteristics such as usability of mobile devices for learning, enhanced collaboration among peers and teachers, learning in multiple contexts, teachers' control over the learning process and independence of learners, costs involved in providing mobile learning for different stakeholders, and mobile learning content design which include appropriate activities and applications in conjunction with the affordances of mobile devices. The mobile learning researchers are investigating these characteristics in conceptualizations and implementations in order to establish criteria for mobile learning design. This paper presents a comprehensive set of common and popular mobile learning characteristics suggested by mobile learning researchers to date; this set of characteristics will provide an input for future research in pursuit of optimum mobile learning design criteria.

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WALKING TOWARDS INSTRUMENTAL APPROPRIATION OF MOBILE DEVICES. A COMPARISON OF STUDIES

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ABSTRACT

The study of instrumental appropriation is considered a relevant outstanding and productive perspective in the arena of Mobile ICT and learning. This paper seeks for the consolidation of this perspective at a theoretical and analytical level. Regarding the theoretical level, two characteristics of mobile devices –flexibility and mobility- are explored in order to make explicit the relevance of the instrumental appropriation. Also, the division of the instrumental appropriation into two levels (external and cognitive) is discussed. Regarding the analytical level, a comparison of European studies are presented, in order to analyze what is the level of application of the 'appropriation perspective' that may be found in the pre-existent studies. Results from this comparison revealed that the consideration of this perspective was limited and unspecific. For a better understanding about the educational impact of the instrumental appropriation more research is needed, specifically regarding the division of the appropriation into the practical level and the human cognitive level

KEYWORDS

Mobile device, instrumental appropriation, educational impact

1. INTRODUCTION: HOW MOBILE DEVICES MAKE EXPLICIT THE RELEVANCE OF INSTRUMENTAL APPROPRIATION IN EDUCATIONAL SETTINGS?

The high mobile technologies penetration worldwide confronts us to an overview around the great impact that the mobile ICT has produce in our contemporary society. Growing studies are analyzing the mobile market share, the mobile advertisement, or the revolution of the mobile applications, among the most relevant (MobiThinking, 2012; Infographic, 2012). However, the mere study of the penetration does not provide enough aid to envisage all their effects, especially at the most profound changes. We are increasingly using the mobile devices for a great number of activities, with a variety of purposes that are changing the way we are used to do the more simple things: reading a newspaper, paying the parking, buying a flight, etc. with strong effects in our instrumental routines. Thus, we need a new perspective for understanding the impact of the uses, because as Bar, Pisani and Weber (2007) pointed out the innovative and long-term effects only happen when users have appropriated the technology, this is, when users has successful and meaningfully integrated it into their activities.

The study of appropriation of instruments, or instrumental appropriation (Wertsch, 1998; Belin, Prié, 2012), is significant for all kinds of technologies; however, we consider this process is particularly outstanding and productive in the arena of Mobile ICT, because of two reasons related to the customization flexibility and the mobility.

First, mobile devices allow personalization both in hardware and software; an example is the digital tablets, which are instruments without predetermined utility. So much so that when the first iPad was born, everyone was asking: ¨what is this? What can I use for? ¨ Appropriation is fundamental in the determination of uses. The own users in their practices create the new technology uses (Salovaraa et al, 2011). Precisely, this context of practice cannot be separated of the understanding of the uses; there is not a main use, the uses

depend primarily on the needs and preferences of users. Also, in this appropriation of uses, any software can be prioritized; thus, the mobile device can be turned into a table painting, a musical instrument, and so on.

And second, the other feature that enables users to make the appropriation is the mobility. The use of instruments is strongly influenced by the context. The same technology or software may have unexpectedly diverse effects, according to specific setting (Tolmie, 2000; Dourish, 2004). The mobility of these devices implies a type of insertion in almost all contexts, and users frequently assign new utility towards the same device (e.g. people often turn on the mobile phone in dark sites and use it like a flashlight).

These two reasons make explicit the relevance of the instrumental appropriation theory, in order to analyze the uses of Mobile technologies. Due to their significance and in order to move this theory forwards to the educational context in this paper we examining, first, what are the main implications for the pedagogical understanding of the mobile devices; then, we present a part of a meta-analysis carried out among the studies of m-learning, in the context of Europe, which aims to identify in what level the instrumental appropriation perspective is considered from the first studies up to now.

2. INSTRUMENTAL APPROPRIATION: A KEY PERSPECTIVE FOR UNDERSTANDING THE EDUCATIONAL USE OF MOBILE DEVICES

Nowadays mobile devices are increasingly integrating in the educational settings. Learning practices using mobile devices, as smartphone and digital tablet, are growing. However, these innovative experiences are still far from being universal. There are few studies on how these technologies are appropriated as educational tools. The scarcity of studies is due to the difficulty in investigating the different uses of these mobile devices, which are generated in a particular context of activity, and many times are evolving according to the development of activities. Even, sometimes, the uses can be made unconsciously and, therefore, the user does not get to identify the usage or utility.

In our study the instrumental appropriation is highly considered, because when a new tool comes into interaction with other elements in educational activities, a number of impacts are produced; from the minimal changes to the more profound, or modifiers of the initial schemata of how, when and where to doing teaching and learning. Specifically, the instrumental appropriation perspective allows us to study the educational impact of Mobile ICT focusing on its influence in two aspects: the change in the educational activities and the cognitive change in the subject, either teacher or student.

Besides, it is important to consider that ‘the appropriation’ is a term widely used in different areas, such as computer science, sociology and education. Computer Scientists like Carroll and his colleagues (2002) consider that the appropriation is a process of the adoption, the adaption and the integration of tool into activities. For those educators like Vygotski and Wertsch (1999), the appropriation is the mechanism of learning, by which the human culture becomes part of the individual psychology. We need to keep in mind that these two visions are not opposed, but compliment; the instrumental appropriation happens at two levels. The first appropriation is the external level or the practice level, that is to say: the adoption, the adaption and the integration of tools into activities. When a new tool is integrated into an activity, the user attempts to dominate and modify this instrument to adapt his needs and preferences. During this process the tool may change, develop and complete in its nature and utility. In this sense the instrumental appropriation is the process of modification and adaptation of the tool in order to be suitable for certain user activities.

The second appropriation occurs at the cognitive level, where take place the acquisition and the construction of new meanings. According to Dourish (2003) and Salovaraa (2008), cultural tools like mobile devices are, themselves, system of meanings. They can be seen as materialization of designer´s knowledge and intentions. Therefore, before and during their use, the mobile devices users need to interpret and understand the properties and functions of the tool. It should be noted that the users do not play a passive role in the process of appropriation. In fact, users can assign new utility to the tool, usually in a way beyond the designer purposes. Moreover, the construction of new meaning is more than an individual process. Haddon (2001) indicates that, after adopting of the technologies in our lives, the discussion, the negotiation and the argumentation still take place with another people about how to use such technology in practice.

This compliment perspective will help us to gain an in-depth and complete understanding about what is happening in the innovative learning practices using mobile ICT. Under this framework, assuming that we are in an early stage of the introduction of mobile ICT in education, the studies up to now are very creative.

In our study we carried out a meta-analysis of the existing studies on applying mobile devices and learning, seeking whether 'appropriation' perspective was considered. In the first stage of our analysis we found that there is a great deal of learning approaches, such as situated, augmented and collaborative among the most cited. However, there are less studies reporting on how appropriation (in the two levels mentioned above) can be best applied in the educational agenda.

In the next section we compare data from three European projects in which we studied the attempts to include the 'appropriation' perspective. This analysis was guided by two key questions:

1.What are the main pedagogical approaches that can give explanation for the use of mobile devices in educational settings?

2. What is the level of application of the 'appropriation perspective' that may be found in the pre-existent studies?

3. INSTRUMENTAL APPROPRIATION: A KEY PERSPECTIVE FOR UNDERSTANDING THE EDUCATIONAL USE OF MOBILE DEVICES

Widespread research on the educational use of mobile devices started from the mid 1990s up to now as a result of a growing understanding of the learning affordances (Pachler et al, 2010). Different kinds of studies and macro-projects have enabled the investigation of mobile learning experiences across several contexts. Data from our research revealed that Europe is one of the areas where more research has been done on this topic. Thus, in this paper we present the results from a comparison of three of the most relevant European projects, including MOBILEARN[1], EMAPPS[2] and M-learning[3] (West, 2012).

In this meta-analysis framed in the European context we considered nine categories: timing, promoting institution, educational modality (according to Coombs, 1985; Coffield, 2000; Schugurensky, 2000; Cross, 2006), target group, goal of the project, specific objectives, the pedagogical approach (as defined by the project), methodology and results. Table 1 summarizes the comparison in between the three projects.

[1] http://www.mobilearn.org/
[2] http://emapps.info/eng
[3] http://www.m-learning.org

Table 1. Comparison of studies on Mobile Learning

	M-LEARING	MOBILEARN	EMAPPS
Timing	2001-2004	2002-2005	2005-2008
Institution	Learning and Skills Network (LSN)	European Commission	European Commission
Educational modality	Non-formal learning	Non-formal and informal learning	Game based learning, informal learning
Target group	Disadvantaged young adult	Mobile workers and learning citizens	Children
Main goal	Help young people between 16-24 years who had no success in the educational system and were considered at risk of exclusion in society, involving them in non-formal learning	Exploring new ways to exploit mobile environments and technologies in order to supply to users a richer, more exciting and satisfactory learning experiences while freely on the move.	Exploring the impact of the educational games on the children learning in the school context.
Specific objectives	Creation of technological system for supporting mobile learning. Development of educational content for mobile learning. Studying the impact of mobile devices to include disadvantaged young people in learning.	Creation of pedagogical paradigms to support learning in a mobile environment. New architectural layouts to support creation, brokerage, delivery and tracking of learning and information contents on the mobile network, which extend existing systems. Selection, adaptation, or creation of existing e-learning contents for mobile devices. Realization of new business models.	Creation both the communities of children and the communities of teachers. Development of educational games on mobile platforms. Creation of a child living map of Europe. Design and implement effective training and multiplier mechanisms for future exploitation.
Pedagogical approach	As both the concept and the practice of m-learning are still very new, the research largely focuses on the exploration of information gathered and further development of hypotheses, rather than on providing pre-existing theories.	Ambient-learning: the development of innovative models for the provision of learning services, fully exploiting the potential of ambient intelligence technologies, enabling ubiquitous, interactive, personalized and tailored access to learning and knowledge on demand to individuals at home, at work or on the move.	The theory of social constructivism Game-base learning
Methodology	The project has developed prototype products and innovative approaches designed to support learning – particularly literacy, numeracy and and survival/life skills – using handheld devices such as mobile phones and palmtop computers or pocket computers	The MOBIlearn research has been, in fact, driven by ¨learning pull¨ rather than ¨technology push¨, paying extreme attention to research into the pedagogic aspects of e-learning, trying to define learning paradigms for ubiquitous applications, with new organizational, business and learning models taking into account socio-economic, competency, cultural and motivational factors	The project has envolved significant effort in terms both of technical development and experimentation in real-world school environments.
Results	As part of a blended learning, mobile learning has the potential to help young people to improve both their skills and their self-confidence. Creation of m-learning infrastructure: LMS and mPortal	Task model for mobile learning. The MOBIlearn system. Pedagogical contents for mobile learning. Market analysis and business modeling.	Development of Mobile games. Revelation of the educational value of Mobile games. Creation of system of game-based learning.

These three projects reflect the development of m-learning research, particularly in the search for a suitable pedagogical theory for this new learning paradigm. Regarding the first, when the M-learning project began, there is little knowledge about the topic. Therefore, the research focused on a collection of data on technological characteristics, user preferences and needs of mobile learning. In this study the process of instrumental appropriation, in this case regarding young adults, was limited although based on the external level, the adoption of mobile devices and the effects on preferences of use. Results regarding the 'self-confidence augmentation' in these users cannot be translated as the effect of appropriation at the second level, or cognitive level; however, it started to glimpse a micro-level in the effects of using mobile devices. More data is needed to corroborate this assumption.

To fill this gap, the MOBIlearn project attempts to define and explain a new learning paradigm. This project made the first efforts to understand the instrumental appropriation. Then, the third project, instead of creating a new theory to understand the m-learning, it aims to measure the impact of technology on the application of existing learning theories (game based learning and collaborative learning).

MOBIlearn project gets to create a mobile learning model, indicating six interrelated factors in this activity: subject, technological tool, control, context and communication. The task model provides a coherent account of how the activities are performed, the people are involved, their contexts, the tools and technologies they employ, the structure of the tasks and an account of their cognitive processes, management of knowledge, and social interactions. The main purpose of the task model was *to describe the interactions between the people and their tools and resources, and to analyze how people externalize their work, through representations of culture product such as notes and diagrams, the rules and conventions that influence the activity, etc*. (Bo, 2001).

It is considered that a dialectical relationship between the six factors exists. In the framework of the 'appropriation', for understanding how people adopt, adapt and use technology, it is necessary to study these relationships. Besides, the research indicates that the mobile learning activity takes place both on the technological space and the semiotic space; and this model can be applied in two levels. Thus, through indicating the importance of interactions between subject and a new tool, together with the existence of two spaces of m-learning activities, this research makes the first step to understand the new learning paradigm from the perspective of instrumental appropriation.

Moreover, this model was created for the design of technological system for m-learning. Therefore, it is divided into two levels: the technological and the semiotic. However, the model has only indicated some factors from the whole range of factors needed to consider the study mobile learning activity, and without explaining the mechanism of instrument appropriation. All this considerations suggest that more studies in reveling the details about this process are needed.

4. CONCLUSION

Mobile devices are instruments that not only affect the mental activities but also influence other human practices. In the context of the activity with the specific user and the specific device are being produced changes in the activities systems, one of the most relevant: the way to carry out the teaching and learning. Therefore, the mobile devices appropriation presupposes an interesting interpretation of the educational activities and the individual cognition.

In our study we found that the application of this perspective was limited and unspecific. However, for a better understanding about the instrumental appropriation and its educational impact, the most suitable way will be the division of the process of instrumental appropriation at the practical level and at the human cognitive level. Considering that there is no fixed model of how to use these technologies in the classroom, an in-depth research on the incipient experiences about the application of the instrumental appropriation, and the division proposed in this paper, is needed. We can start for analyzing those innovative teachers that have to invent the way to integrate mobile technologies in their activities. The focus on the instrumental appropriation by these 'lonely rangers' (Bates, 2001) will help us to understand these new experiences, especially to identify the key factors that affect this educational process.

From our investigation we propose some suggestion for future research on mobile technology use in education:

- Initiating studies for observing educational activities assisted by mobile technology in the real scholar context. It allows researchers to explore the mobile technologies appropriation that occur in formal educational activities; especially to identify how different factors of the formal activities affect the appropriation process.

- New research that focus on the relation of the two levels of appropriation will be useful for identify changes that occur in the activity system; it is important to study what happen in the cognitive level and how does it happen for establish then how must be happen, what can be the most effective way to learning and teaching with mobile technologies.

- To study both the teachers and the students' appropriation experience is noteworthy, especially for the identification of the strategies and the mechanism their use for achieve the appropriation of the tool as an educational tool.

- The appropriation is a process not only of starting but also a long-life process, thus the interactions among teacher-student and student-student are vital to consider how the appropriation is evolving, stopping, increasing… Research about the continuum in between adoption, appropriation, and practice activity will be also relevant.

- The comparative perspective will be also welcome; it will be relevant to carry out studies comparing appropriation that happen in the school context and that happen at the informal context. #

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TWITTER MICRO-BLOGGING BASED MOBILE LEARNING APPROACH TO ENHANCE THE AGRICULTURE EDUCATION PROCESS

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ABSTRACT

The study intends to see how to introduce mobile learning within the domain of agriculture so as to enhance the agriculture education process. We propose to use the Activity theory together with other methodologies such as participatory methods to design, implement, and evaluate mlearning activities. The study explores the process of introducing twitter based mlearning among a group of young farmers by following a series of steps: A situation analysis to explain the mobile technologies or tools available among study community, developing lessons, introducing mlearning among the study group, and evaluating the outcome. It concludes that twitter as a potential low cost ICT solution to facilitate informal learning among the study group.

KEYWORDS

Mobile Learning, Activity Theory, Agriculture, Twitter, SMS

1. INTRODUCTION

Mobile technologies are found to be providing cost-effective and efficient solutions in addressing the information needs of agriculture-stakeholders (Aker and Mbiti, 2010; Dhaliwal and Joshi, 2010; Fafchamps, 2011). The recent experiences in Sri Lanka have also showed that the market prices of agricultural products could be easily delivered to interested stakeholders using SMS alerts ("Dialog Axiata PLC", 2012; Mobitel, 2012). However most of these approaches were limited to sending updates on market prices, weather information but the use of mobile devices in mlearning has got little attention. This study was conducted to see the possibility of introducing a twitter based mobile learning approach to deliver short lessons on agriculture, among a group of young farmers. We have thus, defined mobile Learning in an 'agricultural and informal extension context aimed at the farming community. The context of learning referred to in this work tailors mostly guided informal learning related to in-situ practice of agriculture compared to classroom learning.

2. LITERATURE REVIEW

2.1 Mobile Learning

Keegan (2005) defined mobile learning as 'the provision of education and training on PDAs/palmtops/handhelds, smart-phones and mobile phones. The main focus of this definition was 'mobility. This concept of mobility was elaborated 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 (Impedovo, 2011; Taylor et al, 2006). Another widely accepted definition for mobile learning is using mobile technologies to facilitate learning (Hwang and Tsai, 2011).

Mobile learning via SMS initiative was successfully implemented with a group of distance learners to enhance blended leaning by the Open University of Malaysia (Lim et al, 2011). The learners have appreciated the text messages and felt that the SMSs had helped them to stay focused, engaged in their studies, and had provided them with useful information related to the course. The system had been able to deliver information related to course contents, motivate the students, and provide useful announcements etc. The study has used question answer format in some of the places e.g. multiple choice questions, answers and feedback system which is very much similar to our study.

According to the findings of a meta-analysis (Wu et al., 2012) mlearning has most frequently supported students in various professions and applied sciences. Agriculture is also considered as an applied science, however, the authors have not come across a single research on mlearning related to agriculture. Another review study (Hwang and Tsai, 2011), which focused on mlearning literature from 2001-10, suggests that studies focused on science domain have increased over the years however the evidence of using mobile learning in agriculture has never mentioned. Is this suggesting that the value of mlearning was not yet being fully realized by the agriculture sector?

2.2 Agriculture Education Process

Farmers in rural areas are lacking the access to latest technical information related to agriculture on how to produce an economically profitable crop. By providing this information their yields can be considerable improved (Rosegrant and Cline, 2003). Such efforts', i.e. transferring latest technical information related to agriculture, is known to be agricultural education. It is regarded as mostly a non-formal and out of school education process towards the farming community so as to impart knowledge, skills and attitudes. The ultimate objective of farmer education is to empower farmers so that they will make better decisions leading to improve productivity. Although non-formal trainings are mostly arranged to enhance the knowledge, and skills of farmers, a major part of learning is also include informal and life-long learning. Usually farmers gather a great deal of knowledge and understanding through their experiences, by observing and listening to knowledgeable farmers around them. Thus being mostly an informal learning process, agriculture education process can be particularly benefited by introducing mlearning as reported in Jones et al, 2012.

When considering the farmer education process, learning could take place along four paradigms; technology transfer, advisory work, human resource development, and facilitation and empowerment (NAFES, 2005). Technology transfer involves a top-down approach, which delivers specific recommendations related to innovations, that the farmers should adopt. These practices are brought to the attention of farmers using direct methods of transferring knowledge and skills such as demonstrations, field days, exhibitions etc. Advisory service is when the farmer directly contacts the Extension Officer (EO) in the area to clarify issues related to the crop. For example one might be asking about a remedy for the disease outbreak in his vegetable plot. Human resource development involves mostly the formal training given to rural farmers by government institutions and universities, etc so as to improve their knowledge. Top-down teaching methods were mostly used but the participants were free to choose how to use the knowledge they acquired.

The government appointed field extension officer is responsible for delivering information related to latest technologies to the farmer community. She is the key facilitator for the agriculture education process to run smoothly at the grass-root level. The young farmer clubs which we identified as the study community of our study were usually guided and convened by the EO in the area.

2.3 Twitter

Twitter is a free, Web2.0 technology, which allows the users to communicate online brief text updates. It is known to be one of the most popular social networking and micro-blogging applications, (Wikipedia.org/Twitter). The twitter users can send and receive messages via the web, SMS, instant messaging clients, and etc. Posts are usually limited to 140 text characters in length. Micro-blogging enables a real-time interaction between users, using different devices, technologies and applications (Grosseck and Holotescu, 2008). Twitter can also be accessed through mobile phones SMS facility. Twitter has so far being used for various purposes including disaster communication (Mills, 2009), as a teaching practice to promote active and informal learning (Kassens-Noor, 2012), marketing (Burton and Soboleva, 2011), and assessment

of training (Chen and Chen, 2012). Potential educational uses of twitter has been listed by (Grosseck and Holotescu, 2008) which reflects some of the important aspects that is going in line with our study e.g. creating a learning experience, micro-blogging in informal settings, creating learning networks. Using twitter in educationally relevant ways has increased student engagement and improved grades (Junco et al, 2011). This shows the possibility of using twitter as an educational tool to help target communities towards desired outcomes. One of the primary barriers for adopting Twitter as a pedagogical tool could be the student resistant use twitter for educational purposes. Thus users sometimes have to follow creative methods so as to convince students of benefits such as arousing curiosity, and establishing formal or informal rewards (Rinaldo et al, 2011).

The main reason for selecting twitter for this study was that it is freely available in the region, facilitated by three major mobile operators in the country. Besides it is simple and can be operated with minimum instructions. We capitalized on the 'Twitter for SMS' option, which is an instant infrastructure for mobile communications, which allows the users to connect directly with anyone using a mobile phone. This was necessary that most of the participants had no access to internet and most of them had only basic phones.

2.4 Activity Theory

Activity theory has been widely used in designing mobile learning environments (Uden, 2007). One of the basic principles of Activity theory is mediation, which suggests that human activity is mediated by a number of tools both external and internal (Kaptelinin, 1997). Computers or any other device such as mobile phones, PDAs, can be considered as a group of external tools mediating the human interactions with the world. According to (Kaptelinin and Nardi, 1997) activity theory suggest to studying the principle of tool mediation from two angles; structural properties of tools, and knowledge on how the tools are used. Knowing how to use a tool is as much important as the possession of a tool as a tool comes fully into being when only it is used. Thus the knowledge on tool use becomes a crucial part.

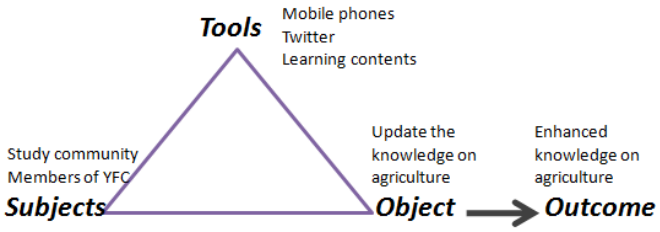

Figure 1. Mediated relationship between study community and object

Activity Theory is also considered as a powerful and clarifying descriptive tool which provides an ideal framework to study the major dimensions of mlearning i.e. learner, devices, and outcome as separate components as well as their interactions (Nardi, 1995). Figure 1 shows how we planned to apply the Activity theory framework to illustrate the mediated relationship of study community and their learning objects. We considered tools such as mobile phones, twitter network, and mlearning contents with the present learning methods of the subjects in order to educate the subjects.

2.5 Focus of the Study

Our study aimed to investigate the use of twitter micro-blogging based mlearning in the domain of agriculture. Having Activity theory as a conceptual framework the following research questions are addressed:

i. What are the mobile/ IT based applications and technologies presently available among the study community, and in what ways we can use these technologies in mlearning?

ii. How can we enhance the agriculture education process using Twitter micro-blogging facility based mLearning?

iii. Is mlearning a possible alternative that can support the target community in fulfilling their immediate training needs?

3. METHOD

3.1 Scope

The study group consisted of the members of Young Farmers Club (YFC) Ancumbura AI range, in Kandy District, Sri Lanka. This YFC group was purposively selected for the study based on their active involvements in agriculture activities for the past 3 years. The main object of the study group was to improve their knowledge related to agriculture and farming practices thus the learning outcome was that the study group acquires enhanced knowledge on agriculture. The tools, or the instruments which mediated the learning process, was regarded as mobile phones, Twitter micro-blogging facility, and the mlearning contents.

3.2 Procedure

The study was conducted in 3 stages; (i) preliminary survey, (ii) introducing twitter, (iii) use twitter network to introduce mLearning.

3.2.1 Preliminary Survey/ Situation Analysis

An initial survey was conducted among the YFC members to see their familiarity with mobile technology, education level, willingness to involve in mLearning, and exposure to twitter or any other SMS based communication methods. A short questionnaire was used for the data collection while about half of the membership, 22 out of 44, was randomly selected for the survey. Then follow-up interviews were conducted with selected respondents to further study the present communication methods used among the YFC members and the EO.

The information coming from the survey was used in the design of the mlessons. For instance, since most of the study group members had access to basic phones, we had to choose SMS based approach for the learning activity. The language we used was Sinhalese, and because they did not have facilities to read Sinhala types, we had to type using phonetic characters. We also had to collect information on income and affordability of mobile technology when we decide upon what type of technologies that would be suitable to offer the mobile lessons. We also looked at the low cost ICT technologies available among the study area considering the economic back ground of the respondents.

3.2.2 Introduce Twitter among the YFC Members and the Extension Officer

Twitter network was established using a series of workshops, in which twenty YFC members and the EO were trained on setting up Twitter accounts, and using them for posting messages. This was done only using their mobile phone. Initially all the YFC members' twitter accounts were set to follow only the tweets posted by the EO and the researcher (Figure 2). Similarly when the members tweeted, it was followed only by the EO and the researcher. This was necessary to avoid members getting too many messages at a time to their mobile phone, and to make the system be as simple as possible for the novice users to understand.

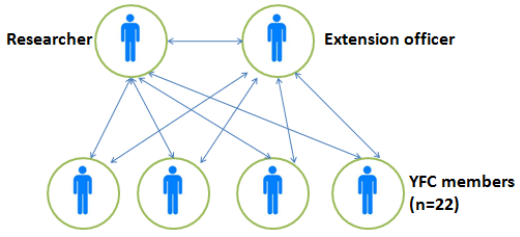

Figure 2. Twitter network developed for the mlearning programme

During this stage, the members were given clear instructions as to how they are going to use twitter, by imposing a few rules:

i. The users should not follow the twitter accounts of each other. They will only follow and followed by the Extension Officer and the researcher.

ii. This twitter network will only be used as an information exchange mechanism, and mlearning platform.

3.2.3 Introducing mLearning

Then we have prepared a series of short-lessons based on primary data sources and were later verified by a subject matter expert. The lessons were split into 2 components as question and answer to as to overcome the 140 character limitation in Twitter. Sending the question first was also helpful to motivate the participants in learning process and stimulate their thinking, before we present with the answer to the question. At this stage members were informed that they could send as many answers and they could get the help of external members to find answers for the questions. In this manner, they will develop their own network to collaborate during the learning.

The question was tweet around 8am in the morning. Those who wish to answer the question may do so by replying to the tweet. These answers will be viewed by only the researcher and the Extension officer. At the end of the day, the lesson was tweeted which explains the answer to the question. Immediate feedback was given for those who answer the question to encourage their participation. Following the comments made by Rinaldo et al (2011) a reward system was being introduced to further motivate the YFC members those who take part in the mlearning programme.

The learning was evaluated using ongoing assessments and focus group discussions. Ongoing assessments were conducted using the twitter network. Six members from the learning community participated in the focus group discussion. Key informant discussions were held with the EO to learn the progress. So far used to study how the AI and members of YFC using twitter to communicate agriculture related information. The user feedback was also obtained during the discussions.

4. RESULTS AND DISCUSSION

The findings of the study are presented based on the research questions.

4.1 What are the Mobile Based Applications and Technologies Presently Available among the Study Community, and in What Ways We Can Use These Technologies in mlearning?

Majority (72%) of the respondents had a mobile phone in their possession while the rest of them had CDMA connections shared with the family. The major mobile operators in the area were two private companies and both these operators acted as carriers of Twitter using short code 40404. The respondents those who possess mobile phones, including the school children, were quite familiar with sending and receiving SMS. These young people were quick to pick this type of technologies and all of them had used SMS options to communications.

We also looked at the types of facilities available in their phones in addition to the SMS facility, and their familiarity of using these facilities. This knowledge was necessary for the planning and development of mlearning lessons for the study community. They were familiar in using the camera (36%), video camera (31%), phone book option (45%), voice recorder (22%) internet (17%), and radio (31%) available in the mobile phone. The types of the phones used among the YFC members were also investigated. Only one member had a smart phone, while six members had java enabled phones. The average monthly expenses for the phone LKR 440 (range LKR 150 - 3000). This indicates their familiarity with technology, which would be useful when designing the initial mlearning contents.

None of the respondents were aware on twitter micro-blogging facility neither over the internet or using mobile SMS facility. However there were very few YFC members who had used other social media such as Facebook on their mobile phone. The same YFC members had email accounts and were seen using them in day to day communications.

The study community mainly consisted young people whose age ranged from 16 -31. These included both school going, and school leavers. Almost all were well educated having attended school education for more than 11 years. Nine out of 22 (41%) had studied agriculture as a subject in the school. The young farmers were mainly in floriculture business and home gardening. School going YFC members were seen helping their parents for the family's ongoing farm/ floriculture business. The members had favourable attitudes towards using mobile technology based mechanism to exchange agriculture related information. An SMS based information exchange mechanism was preferred by the study community mainly due to the lower cost, familiarity with SMS, accessibility to mobile phones, and literacy.

4.2 How Can We Enhance the Agriculture Education Process Using Twitter Micro-Blogging Facility Based mlearning?

The twitter group has been developed to link 3 parties namely YFC members, The EO, and outside sources such as researchers, universities, NGOs, or private sector. As shown in figure 3, twitter provides a low-cost platform to communicate among the involved parties. This need to be a two way communication process so that participants can interact with each other to share important information. These interactions will be helpful for the YFC members to learn different aspects of agriculture, which ultimately contributes for enhancing the agriculture education process.

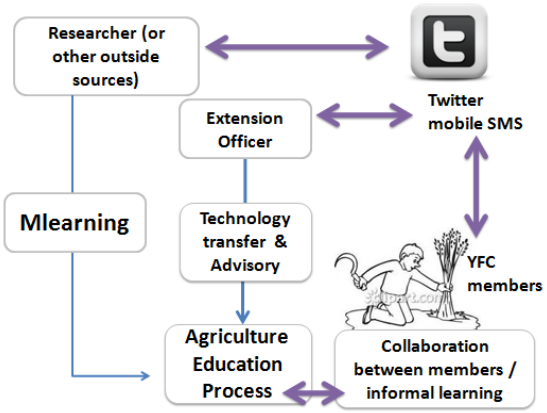

Figure 3. Proposed Model to enhance agriculture education process using Twitter based mlearning

4.3 Is mlearning a Possible Alternative that Can Support the Target Community in Fulfilling their Training Needs?

Our Twitter group consists of 24 members including 22 YFC members, the EO and a researcher representing the outside community. We have run this Twitter network since August 2012 to date, and so far we have used the network to post general announcements by the Extension officer and to post nearly 80 mlessons. The EO had used for variety of purposes; aware the members on agriculture radio programmes broadcast on local radio channels, related training programs, plant clinics, exhibitions etc and scheduling YFC meetings. Most of these messages were to direct the members towards learning opportunities, which they would not aware on otherwise due to the rural areas they were based on. For instance figure 4 shows one such occasion where the Extension Officer tweeted on a radio programme directing the members to listen to it.

Manjula Wijesinghe @AI20122 10 Sep Sahal tambema niwaridi kramaya danaganna suwadashiya sawaya 6.30p.m ahanna. A.I.ANKUMBURA Collapse Reply Retweet Favorite	Translation: "Listen to …FM radio channel at 6.30pm today and learn how to parboil rice. AI (Extension Officer)

Figure 4. A tweet posted to aware YFC members on a radio programme

Secondly the network had been used the mlearning plat form. One of the MCQ questions and the answer posted in the system is given in Figure 5. We have used both MCQ and open ended question formats. Average 10 members out of 22 actively participated in the programme by every day while 3-4 members provided answers occasionally. The rest 8 were very irregular in their involvement and a few did not participate. Immediate feedback was given to those who answer the day's question, using twitter's direct messaging option, so as to prevent other members getting loads of unnecessary messages. The YFC members were allowed to send as many answers possible, however most members were able to provide the correct answer within maximum of 2-3 attempts. The users have developed their own a network of outsiders to help them with finding the answer for the question. The names of users who provided correct answer were tweeted each day for motivation.

Uvasara Dissanayeke @UlDissanayeke 3 Dec Q36: 'Perakum' prabhedaya ayath bhogaya kumakda? a. Thala b. Kavupi c. kesel d. ratakaju	Translation Q36. Which of the following crop has 'Perakum' as one of its recommended crop-variety a. Gingelly, b.Cowpea, c. Banana, d. groundnut
Uvasara Dissanayeke @UlDissanayeke 3 Dec Q36:pilitura: 'Parakum' yanu kesel prabhedayaki.	Translation Q36. Answer: "Perakum" is one of the Banana varieties recommended by the Dept of Agriculture

Figure 5. Tweets in QA format used for mlearning

The users were overall satisfied on the learning programme. We have asked their comments to improve the program and the necessary modifications were made based on their requests. One of the limitations in the study was that users were only allowed to interact with the EO and the researcher. Character limitation of 140 for a tweet was another concern, as we used Singlish typing which could further limit the effective number of characters we could use. We were able to meet this challenge by breaking the mlearning lesson into two components as a question and answer. The contents we have selected for the study were simply to increase their knowledge, and were not to go for deeper level of learning.

5. CONCLUSIONS

This study highlights the process of introducing twitter based mlearning among a selected community. Activity theory was so far used to structure the study, while using its main concepts in planning the various stages of the research. Participatory research methods were used along with Activity theory to capture the dynamics in the mlearning situation. Twitter mobile SMS option provides a simple and low cost information exchange mechanism to initiate mlearning among the study community. However this needs proper planning and closely following the study community to identify their immediate training requirements. The twitter direct message option was used to form rich interactions with users to offer them feedback for learning. In future, it is important to test the applicability of same learning procedure among other communities.

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DESIGNING MIXED REALITY MOBILE GAMES FOR CRISIS MANAGEMENT TRAINING

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ABSTRACT

Games for crisis management offer an interesting complement to traditional training. Experiments on their usage show that games can be promising tools able to address some of the limitations of traditional training. Also our first assessment with a board game for panic management shows that this particular kind of game could be useful for soft skills teaching in crisis management. However the tested board game is not able to address all the elements characterizing crisis management, and in particular teaching field practices. For this reason we decided to add to the first board version, a mixed reality mobile game. With this game we want not only to train soft skills, but also to provide a more authentic learning experience. In this paper we describe the design challenges linked to this type of games explaining how we addressed them.

KEYWORDS

Serious Games Mobile games, Mixed Reality Crisis Management, Authentic Learning, Training for Emergency workers.

1. INTRODUCTION

Crisis management training through serious games has the potential to develop different skills: the ability to anticipate; an enhanced capability for teamwork; learning to cope with short response times; a better understanding of the value of/need for stress management; sharpened business judgment skills; enhanced lateral thinking and creative skills; greater sensitivity to weak signals of abnormality; and better acceptance of change. All these aspects are skills needed for crisis management (Roberts et al, 2002). Some already existing games for crisis management (see for example Incident Commander or Hazmat Hotzone) offer an interesting complement to traditional training. Though for none of them we have been able to find long-term evaluation of their impact, initial results of usage show they are promising tools addressing some of the limitations of traditional training. Also our first assessment with a game for panic management (Di Loreto, 2012) - a board game named Don't Panic - shows that this particular kind of game could be useful for soft skills teaching in crisis management, even having low development cost as a requirement. In addition, the experiment has shown a high level of acceptance of this kind of tool for the domain. However the tested Don't Panic version is not able to address all the elements characterizing crisis management. For example it's very difficult (if not impossible) to implement in this kind of games at low cost an adequate context or adequate actions able to teach work procedures in addition to soft skills. For this reason we decided to add to the first board version an augmented mobile game named MoDo. The main aim of this addition is to conceive different games that can communicate in a coherent way, allowing at the same time centralized management from the coordinators' part and interaction with the territory from the active workers part. In this way we can train different soft skills, using different games, but also teach on the field practices. Our main research question for this latter game is then trying to understand how to design a mixed reality mobile game (i.e. a game which merges real and virtual worlds to produce an environment where physical and digital objects co-exist and interact in real time) able to address soft skills and procedure teaching, and ensuring authentic learning. In the rest of this paper we describe the design challenges we encountered explaining how we addressed them in MoDo. In particular, next section analyzes the learning problems to be addressed during the design of such a game, Section 3 describes the game we designed to address such challenges, while Section 4 draws some conclusions and future works.

2. TOWARDS THE DESIGN OF A MIXED REALITY MOBILE GAME FOR CRISIS MANAGEMENT

To design a game able to address the above described situated training we decided to opt for a multilevel approach at the intersection of authentic learning, game based learning, and mobile learning. In the rest of this section we describe why these domains are needed in the design phase, while in next section we describe a game design which takes them into account.

2.1 Authentic Learning

Authentic learning is a pedagogical approach that allows students to explore, discuss, and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that are relevant to the learner (Donovan et al., 1999). In this approach the emphasis is based on the assumption that in classical learning information is stored as facts rather than as tools (Bransford, et al., 1990). A rather classical example is the driver with a physics degree attempting to dig the car out of sand instead of partially deflating the tires. Herrington and Oliver (2000) offer an interesting analysis defining the following critical characteristics of authentic learning:

1. Provide *authentic contexts* that reflect the way the knowledge will be used in real life
2. Provide *authentic activities*
3. Provide access to *expert performances* and the modeling of processes
4. Provide *multiple roles and perspectives*
5. Support *collaborative construction of knowledge*
6. Promote *reflection* to enable abstractions to be formed
7. Promote *articulation* to enable tacit knowledge to be made explicit
8. Provide *coaching* and *scaffolding* by the teacher at critical times
9. Provide for *authentic assessment* of learning within the tasks.

We will return on these aspects several times in this paper as we consider them criteria to meet when creating a game for crisis management.

2.2.1 Why to Use Authentic Learning for Crisis Management?

Crisis management is complex and we do not aim at its complete characterization, but rather outline general issues to consider when designing serious games. Let's use a simplified example to help us in this task. During a weekday, a truck transporting toxic material has an accident. If it gets in contact with air, the material could cause a major air contamination. The problem requires the coordinated intervention of multiple units: firefighters trying to avoid contamination; medical units taking cares of the injured; police trying to avoid traffic problems; Civil Protection activating evacuation plans and preparing sheltering for the population. As it is often the case, we are dealing with a wicked problem, i.e. a problem that does not have a univocal solution, but different solutions with associated costs and risks. In this scenario we can identify:

Predictable and Unpredictable elements: A complex interleaving of predictable and unpredictable events characterizes most crises. In our example, accidents involving vehicles transporting hazardous material are a well-known problem for which protocols of action are defined. However, nobody can predict when this will happen and the precise context, e.g. type of material, weather conditions, or population in the area. The involved units must manage the emergency as it unfolds.

Problem dissection: During a crisis, the main problem is broken down into manageable sub-problems, e.g. taking care of the injured, putting population in safe conditions, and so on. Generally, specific emergency units are allocated to each sub-problem.

Making plans: Once the main problem is dissected, action has to be planned. Each unit might define plans for sub-problem they have to handle, but with the need to coordinate the effort. Plans have to conform to approved protocols of action. They might act as maps or scripts depending on a specific situation and the role of the people involved, for example volunteers with low training have generally no authority to change a plan.

Local optimum vs. global optimum: Action leading to an optimal result locally is not always leading to the intended global result. For example, divert the traffic in one direction might reduce congestion in one area, but create problems to emergency vehicles parked in another road.

Communication and cooperation: Members in a crisis management team need to communicate to coordinate their action, e.g. keeping updated and negotiating changes in the plan, but also to cooperate to get the work done.

Roles: Crisis management is characterized by a clear definition of roles at the organizational, team, and individual level. Members of the emergency team can aggravate the situation if they do not accept leadership or refuse to act within their, possibly limited, action space.

Limited time for decision-making: In most crises, events can quickly deteriorate. In our example, the truck can start spilling out hazardous material and contaminate the air if the team is not able to act quickly.

Links to the territory: Crises do not happen in a vacuum, but are deeply grounded in specific social and physical contexts that influence their management, e.g. an event like the one in our working example happening in a highly populated area with schools nearby poses different requirements than if the accident happens in an isolated area.

Asymmetric information: Not everybody has access to the same information. Coordinators might have a better overall perspective, while workers deployed in the field might have more detailed and updated information regarding a specific area. No one can be sure to work with information that is complete, fully reliable, and accurate.

Quick convergence towards an objective: Though the time span varies with the specific situation, crisis management has the aim to quickly converge towards the "normalization" of the situation.

Coaching: Crises involve people with different levels of knowledge and experience. Actions that are almost routine for some of the workers might be extremely challenging for newcomers, both technically and in terms of emotional response. Though there is often limited time for discussion, and everybody has to act within their role and time constraints, there are continuous micro-sessions for informal coaching where workers support each other, providing suggestions and warnings.

Debriefing: After each event a debriefing session takes place to understand the critical aspects linked to the intervention. Debriefing sessions might significantly vary in terms of level of detail and people involved. For example, debriefing sessions might be conducted separately from each unit or together, if the focus is on coordination. Workers at all levels might be involved to use the session as an occasion of reflective learning at the individual and team level, while in other cases it might involve only top management to reflect of suitability of the defined protocols.

Actually, authentic learning is already used in crisis management. Learning from experience is promoted through structured debriefing sessions evaluating e.g. the application of existing protocols and team coordination. As a complement to real experiences, exercises that are simulating different crisis scenarios are regularly organized. These exercises can be seen as field tests that allow acquiring experience on specific events in a controlled and safe environment. Simulations generally involve different forces to manage an event, for example an earthquake. In this way, the simulation serves to test not only the responsiveness of a specific body, e.g. firefighters, but also the capability of different forces to coordinate their activities. Simulations are however very costly, requiring a large deployment of personnel and equipment. In addition, having situated learning is not always possible. For example most of the time using city centers for situated learning is avoided – in order to avoid panic spreading – cutting out the possibility to train in such environments. For this reason, computer based simulations have been proposed to facilitate training (e.g. Dobson, 2001 and Granlund, 2001).

2.2 Serious Games and Learning

The serious games movement started with the U.S. Army's release of the video game America's Army in 2002. The same year the Woodrow Wilson Center for International Scholar in Washington, D.C. founded the Serious Games Initiative, and the term "serious games" became widespread. The term itself is nowadays established, but there is no current single definition of the concept. Serious games usually refer to games used for training, advertising, simulation, or education, which are designed to run on personal computers or video game consoles. Corti (2006) considers that Game-based learning (GBL) and serious games have the potential of improving training activities and initiatives by virtue of, e.g., their engagement, motivation, role playing, and repeatability: failed strategies etc. can be modified and tried again. Digital game-based learning (DGBL) is closely related to GBL, with the additional restriction that it concerns digital games. Analyses have been conducted over the years, consistently showing that games promote learning in rather classical settings (see

e.g., Szczurek, and Van Eck, 2006) while in more applied field - like the health field - researches are still actives,(e.g. with the game L'affaire Birmain to teach children how to manage their diabetes and post stroke rehabilitation games, see Di Loreto et al., 2011).

2.2.1 Why to Use Serious Games for Crisis Management?

Training in crisis management is complex and it requires a combination of methods trying to reproduce as much as possible real life situations to teach best practices. However in crisis management training is important to support both aspects – specific procedures and soft skills: "The key to effective crisis management lies not so much with the writing of detailed manuals (that have a low likelihood of being used) and practicing location evacuations as with structured and continuous learning processes designed to equip key managers with the capabilities, flexibility and confidence to deal with sudden and unexpected events." (Roberts, 2002)

One of the ways to address this complex scenario could be the usage of serious games. While simulation can help the crisis management team to find the optimal response to the crisis, serious games can help them, for example, in the art of optimizing the limited time that they have to develop creative responses to the crisis within the procedural constraints of the situation. The flexible rule structure can allow the learners to explore the game space, test hypothesis, and fulfill goals in a variety of unique, sometimes unanticipated, ways. However while there is a good potential to develop soft skills (e.g., communication styles during a crisis, team management and coordination, time management, stress management) and to transfer them in real life situations (see Charsky, 2010; Tang, 2012) it's not so evident that the hard skills learned through a game can be applied to a variety of real world situations. In particular if we look at the elements characterizing authentic learning described in previous section, we can see that the usage of classical electronic game simulations can allow for e.g., the usage of *multiple roles and perspectives*, while it's more difficult to insert *authentic contexts* and, above all *authentic activities*. In order to add them we will have the same problem real life simulations have: a high fidelity context, providing authentic activities with authentic reactions, means a very structured game or simulation, which on the other hand means high (development) costs.

2.3 Mobile Learning

In their paper "Towards a Theory of Mobile Learning" Sharples and colleagues (2005) distinguish what is special about mobile learning compared to other types of learning activity. An obvious difference is that it starts from the assumption that learners are continually on the move. We learn across space as we take ideas and learning resources gained in one location and apply or develop them in another. We learn across time, by revisiting knowledge that was gained earlier in a different context, and more broadly, through ideas and strategies gained in early years providing a framework for a lifetime of learning. We move from topic to topic, managing a range of personal learning projects, rather than following a single curriculum. We also move in and out of engagement with technology, for example as we enter and leave cellphone coverage. As we can see in this approach it is the learner that is mobile, rather than the technology.

2.3.1 Why to Use Mobile Technologies for Crisis Management?

In blurring the physical and scheduled personality of institutional-based learning, time-space implications of mobile learning open up opportunities for a wide variety of pedagogical patterns. Mobile technologies thus enable learning to occur in a multiplicity of more informal (physical and virtual) settings situated in the context about which the learning is occurring (Kearney, 2012). However apart from these theoretical considerations actual mobile learning still suffers from a prejudice linked to the content aspect. While in current mobile learning it's clear that the learner is mobile, the accessed content is still rather classical: the learner gets information through the mobile device. On the other hand mobile games use a totally different approach on the matter. In games such as *Can you see me now* and *Uncle Roy all around you*, the context is the content. The people playing the game and the place the game is played in are strongly part of the game dynamics (i.e., the actions the player can do). As we were looking for a low cost way to implement situated learning for crisis management we decided then to look into this kind of approach, designing a mobile game, augmented with smart objects. The design of this game and its advantages for crisis management teaching are described in next section.

3. MODO, A MOBILE MIXED REALITY GAME

To summarize previous sections, our main research question was: is there a way to address crisis management characteristics, in an environment that can allow for authentic learning through a mobile serious game? To answer this question we designed the mobile mixed reality game called MoDo which is described hereafter.

Game dynamics. MoDo is structured to be played in teams in a physical environment through the usage of mobile devices and technology-augmented objects (see Fig. 1 & 2). Each team has to complete its mission, to evacuate the people inside a zone or a building, before the other team does. This means that the teams have a limited amount of time to complete their missions using the resources (such as augmented hammers, chains, and the like) they are provided with. After this time they automatically lose the game. The game starts with a particular situation in the zone - for example a certain amount of wounded people, panicked people, collapsed walls, and so on - and the teams have to explore the territory in order to save people. However the players are able to see what the situation in a zone is, only by being in proximity of that zone (e.g., they will see the number of panicked people in a room only if they are near that room –see Fig.1). At the end of the game the teams will be ranked following the time used to complete their mission and the number of people they were able to evacuate. This means that each team has to "collect" and evacuate the maximum number of people in a limited amount of time. To do so the team has to bring the "collected" people back to the entrance point of the building/zone. The social aspect of the game includes then collaboration within the same team and competition between teams. The game is conceived so that only few key points are fixed: (i) the resources usable by the teams are limited; (ii) there is a limited time to complete the missions. All the rest of the game is linked to emergence dynamics (e.g., when and in which way the players use the resources, if they communicate/coordinate or not, and so on.) All the movements and events are tracked so that they can be used in the debriefing phase

Learning objectives of the Game. MoDo has multiple aims linked to soft skills and best practices. The missions inside the game are conceived to push local vs. global reasoning, problem dissection and making plans as dividing the game arena into zones and adding unpredictable events during the game which can create contrasting reasoning and priorities. The content of the game reflects real life information and events linked to crisis management. As the game is played in a real environment the players have to learn to use their competences taking into account also the other players and the environment they are playing in. All the teams are given a limited amount of resources and they have to use them wisely. Resources (typically physical objects augmented with sensors) are used to interact with the territory/building in order change a potentially dangerous situation. Finally not all the members of the teams have access to the same information (i.e. we implemented asymmetric information inside the game).

In addition MoDo addresses several aspects described in section 2.1.

1. Provide *authentic contexts.* The MoDo game is played in a real environment so that sensible areas in the city or of a building can be used for training. The game provides the narrative context for the situation in a real environment and the possibility to create tailored content for each group at low cost.

2. Provide *authentic activities.* All the actions that the players are able to use within the game were discussed with experts. Also the choice of which kind of tool to augment was decided following experts interviews (see next subsection).

3. Provide access to *expert performances* and the modeling of processes. This is the classical advantage of electronic games. As we can stock previous performances, novice players can compare their current performance with the ones from more expert players.

4. Provide *multiple roles and perspectives.* In MoDo Each team playing the game is composed by multiple roles: firefighters, first aid, and dog trainers. This mix allows simulating real life interchanges.

5. Support *collaborative construction of knowledge.* The mixed team structure and the game rules allow for intra team communication and collaboration in order to solve a common problem. The expertise shared has then the possibility to evolve - through time and through the usage of debriefing sessions -into knowledge.

8. Provide *coaching* and *scaffolding* by the teacher at critical times. This is a possibility left open by the game. If the teams are composed by more and less expert players, the experts can help the less expert in solving a problem.

A separate discussion will involve the points left behind as they can be characterized as post-game assessment more than in-game characteristics. We will return over them in the final section about future works.

Validating the gameplay through experts' interviews. In order to validate the game concept before the implementation (i.e., to validate if the elements we put in the design were really able to address the 6 points we analyzed) we conducted an expert evaluation with 4 crisis and emergency experts. Two of them were civil protection leaders, the other two came from the industry as sellers of emergency software and one of them in particular is a volunteer firefighter with a long experience. We used scenarios and low fidelity mock ups to discuss about the game. This expert evaluation allowed us to validate some game design aspect (such as the usage of the augmented objects) and to erase some other (like the kind of movement patterns the players have to follow in order to save the trapped persons).

They considered the whole game as a possible successful training means and the comments we got from the experts were directed towards little changes in the game dynamics while the scenario was easily accepted as realistic. In particular comments went into the direction of hints about *how to stick to real life procedures.* For example we were explicitly asked to add in the gameplay the necessity to bring people in a common room for a triage operation. Also the importance to find a way to keep track if the augmented object were used in the right sequence was underlined.

4. CONCLUSIONS AND FUTURE WORK

In this paper we described a mixed reality mobile game named MoDo. Our main research question was to understand if this kind of game can help learners through the usage of authentic learning. Experts' interviews conducted with crisis and emergency experts provided an initial validation of the game design for such a use. First of all MoDo is a low cost augmented game. Not only the game dynamics can be easily implemented on different platforms, but it is also possible to do hardware choices to keep the costs low (like in the solution we are using -everyday objects augmented through Arduino and barcodes). While it's true that this kind of game requires an initial setup, everything is mobile in the sense that everything can be used with little effort in different settings. Finally, the way the game is constructed –mixing real objects, mobile augmented reality, and real environment- seems to be a good low cost alternative to train emergency experts.

Currently we are developing a prototype of the game to evaluate it in use and understand its impact on learning. We are also investigating how to support the core aspects of authentic learning identified in (Herrington and Oliver 2000), see Section 2.1, that are not addressed in the current game design: 6. Promote *reflection* to enable abstractions to be formed and 7. Promote *articulation* to enable tacit knowledge to be made explicit. During our experts interview we got several hints about what could be useful to track during the current game session. The tracking can then help in structured debriefing sessions, but also to promote quick and long term reflection at the individual as well as at the group level. Finally we have the evaluation challenges. This is a more complex problem for this kind of domain, as this assessment can be done only after a real emergency. However we are planning to compare the results from the usage of our application with the ones from classical simulations to understand if the game at least is able to provide the same training.

Figure. 1 and 2. Storyboarding for the MoDo mobile augmented game

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FROM LEARNING OBJECT TO LEARNING CELL: A RESOURCE ORGANIZATION MODEL FOR UBIQUITOUS LEARNING

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ABSTRACT

The key to implementing ubiquitous learning is the construction and organization of learning resources. While current research on ubiquitous learning has primarily focused on concept models, supportive environments and small-scale empirical research, exploring ways to organize learning resources to make them available anywhere on-demand is also crucial. This paper presents a new organizational model for organizing learning resources: Learning Cell. This model is open, evolving, cohesive, social and context-aware. By introducing a time dimension into the organization of learning resources, Learning Cell supports the dynamic evolution of learning resources while they are being used. In addition, by introducing a semantic gene (knowledge ontology) into the model, Learning Cell can describe the internal structure and external relations of learning resources more flexibly, allowing the evolution of learning resources to be controlled in an orderly way. Furthermore, by employing a computational model of a social cognition network, Learning Cell enables not only materialized resource sharing but also the sharing of social cognition networks. Finally, by separately deploying resource structures and resource content in the cloud storage model, Learning Cell achieves context awareness of u-Learning resources. Learning Cell represents a resource aggregation model that is different from the learning object model. It makes up for the defects of existing learning technologies in the following areas: the sharing of process information and social cognition networks, the intelligence of resources, and the evolution of content. Learning Cell provides a theoretical framework for and practically explores the possibilities of u-Learning resource organization.

KEYWORDS

Ubiquitous learning; learning object; learning resource; resource organization model

1. INTRODUCTION

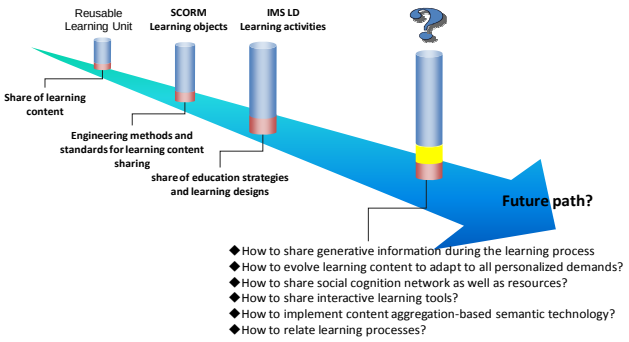

Figure 1. The development of learning resource sharing

Three generations of resource organization models have shaped the field of e-Learning: Integrable-ware (Reusable Learning Unit), Learning Object and Learning Activity. Figure 1 shows the development of learning resource sharing. The Integrable-ware model (Li, 1997) initiated resource-sharing research; it emphasizes the combination and reuse of small-sized learning resource units. The Learning Object model (ADL, 2004) provides solutions for data exchange between different Learning Management Systems (LMS), allowing structured and interactive learning objects to be shared between LMS. The Learning Activity model (Britain, 2004) supports high-level sharing of learning processes and activities by reusing learning methods, learning strategies and learning activities. The emergence of IMS-LD (IMS GLC, 2003) extended the sharing of learning resources from learning objects to learning activities, signaling a shift in learning resource sharing from a technological problem to an education problem.

However, the sharing of learning activity designs is not the ultimate goal of learning resource sharing. New learning technologies aim to cater to ubiquitous learning.

2. RELATED WORKS

Existing learning resource standards, such as IEEE LOM, SCORM, etc., focus on describing and packaging resources, and their primary goal is to enable resource sharing and reuse across different platforms. Undeniably, these resource technologies play important roles in promoting learning resource transmission and sharing, but they only support one-way information transmission (experts generate resources while users consume them). Such models ignore the valuable information generated by learners during the learning process, making the update cycle too long and unsuitable for users. Existing resource standards that are designed for traditional e-Learning are characterized by knowledge transfer tools and are, not suitable for new learning modes like collaborative learning and discovery learning, where resources can be collaboratively developed and shared using social networks.

Because the existing learning resource sharing standards do not conform to the development of learning technologies, some international research groups have initiated work on the next-generation model for sharing learning resources. For instance, the Instructional Management System Global Learning Consortium (IMS) has published the Common Cartridge V1.0 standard (ADL, 2008). In addition, Advanced Distributed Learning (ADL) is working on a standard called SCORM (Sharable Content Object Reference Model) version 2.0 (Allen, 2008). Although in development, these standards in some ways reflect the defects of existing sharing models, and reflect the demands of researchers and practitioners for next-generation sharing models.

SCORM 2.0 and IMS Common Cartridge show that international standardization groups have made significant contributions for the development of learning technologies. However, they are not suitable for application in u-Learning for the following reasons:

(1) Both of these projects allow the integration of resources of a variety of sources and types but fail to plan and design tools that would enable the renewability of these resources. To date, Web 2.0 communities such as Wikis, interactive Q&As and professional BBSs, which users actively participate in to construct content, are common tools used by many learners to search for information, seek help and troubleshoot. Therefore, the goal of research aimed at learning resource development is to structurally support the assimilation of collaboratively created/edited learning resource content, to promote its evolution and development and to completely preserve and share the record of resource evolution and knowledge construction.

(2) They ignore human factors in resource organization. Learning Object models only consider file organization and packaging, it has no human factors. Learning design goes a step further by enlarging the sharing scope to the design ideas of teachers and allowing learners to participate in pre-defined learning activities. However, it does not support relationship construction between learners. Based on cognitive learning theory, a P2C (People to Content) learning mode cannot reflect the essence of e-Learning because learning essentially consists of interactions between people, and the most valuable e-Learning mode should be P2P (People to People).

(3) They are unable to meet informal learners' needs for individualized and diversified learning. The intelligence characteristics of these learning resources are insufficient to provide the personalized and diversified learning demanded by informal learners. Most of the current learning resource standards are static metadata schemes that ensure shared cross-platform characteristics but sacrifice flexibility. These schemes hardly meet the expansion needs arising from the varied application scenarios. The semantic tagging and modeling of learning resources would provide the data foundation for adaptive learning (Jovanović et al., 2007; Bouzeghoub et al., 2006; Nilsson, Palmér, & Naeve, 2002). Some researchers have tried to use ontology technology to build models of digital courses, yet these studies are limited to curriculum in specific disciplines. There are few general descriptive models and application tools (including modeling tools, retrieval tools, reasoning tools, etc.) that can be adapted to a variety of subjects. Ubiquitous learning requires intelligent, situational and adaptable resources. A resource organization model designed for a ubiquitous learning environment must take this into consideration.

(4) SCORM, IMS learning design standards and Common Cartridge norms are all structurally appropriate for creating complete course and teaching units and emphasize one-way designs in which developers and teachers organize and transfer learning content and activities. This is appropriate for formal learning styles that involve teacher participation. This limited sharing range and prevents resources from being imported and exported between different LMS. The models in question allow for neither a wide range of resource sharing across organizations nor the miniaturization of sharing grain size and thus do not meet the requirements of informal learning, i.e., short time, miniature study particle size. It also limits the scope of sharable learning resources to learning content and instructional design and does not allow the information generated in the learning process to be shared. Generative information produced during the learning process is an appropriate object for observation that can promote learners' learning.

Based on the above problems, this study attempts to go beyond Learning Object and proposes a new sharable learning resource model for u-Learning. The innovative features of the model include its context-awareness, evolutionary development, cognitive network connectivity and semantic-based aggregation. We also present the runtime environment design and implementation of the model.

3. THE PROPOSED MODEL: LEARNING CELL

Because they are based on centralized storage and hierarchical directory structures, existing learning resource organizations cannot meet the demands of u-Learning. In this paper, we propose a new learning resource describing and packaging scheme called Learning Cell, which is evolving, open, intelligent, cognition-connected and semantic-aggregated (Yu, Yang, & Cheng, 2009).

3.1 Principles of Learning Cell

To accommodate u-Learning, Learning Cell is based on Connectivism and collaborative knowledge construction theories and features cloud storage, a dynamic structure and non-static data elements. As a digital learning resource, Learning Cell is generative, open, self-evolutionary, connective, social, micromatic and intelligent. The meaning of "cell" is multifold:

Component: It reflects the characteristics of standardization, micromation, reusability and integrability that define Learning Cell. From this perspective, the design concepts of Learning Cell and learning object models are similar.

Original: Learning Cell develops from non-existent to existent, from small to large, from large to strong and finally to long-lasting. Learning Cell changes during the usage process rather than remaining static. The evolving and germinating characteristics of Learning Cell distinguish it from learning object models.

Neuron-like: Learning Cell is able to perceive environments, adapt to terminals and generate rich connections. The connections among Learning Cells and humans form social cognitive networks. When those networks grow to a certain scale, Learning Cell would gain social intelligence, which is also an essential distinction between Learning Cell and learning object models.

From the above descriptions, we can see that Learning Cell is a learning resource that is open, generative, evolvable, connected, cohesive, intelligent, adaptive and social. It is developed from the Learning Object model and designed for u-Learning. The basic idea is to introduce a time dimension and an interpersonal cognition network into learning resources to make the learning resource evolvable. During evolution process, generative information and the revision history are recorded, an interpersonal network is generated and human and knowledge connect with each other to form a knowledge network, which allows students to construct knowledge, understand the context of that knowledge and share collective wisdom through social cognition networks.

3.2 Structural Model of Learning Cell

Learning Cell uses the cloud storage model to support u-Learning resources. The structure of learning content and the learning content itself are separated in distribution, as Figure 2 illustrates. Learning Cell is composed of dynamically structured resources: metadata, ontology, content, activities, assessments, generative information and multi-formats. All of these components connect with the "Education Cloud Services"

through a variety of service interfaces (e.g., learning activities and assessments). In "Education Cloud Services", there are an immense amount of learning resources and various related records, including activity records, editing records, evaluation records, use records, learning communities and other information generated during learning processes.

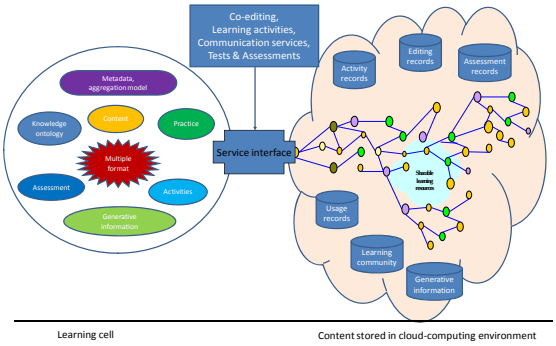

Figure 2. The Cloud Storage Model for ubiquitous learning resources

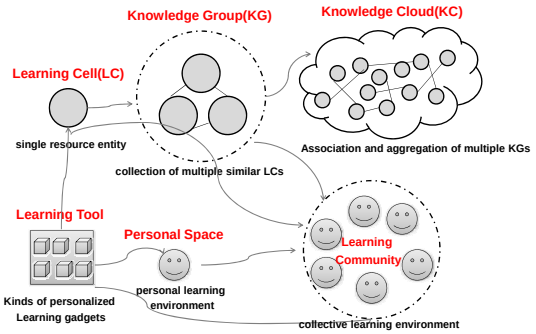

Figure 3. Functional model of the Application Layer of the Learning Cell runtime environment

Learning Cell is a learning service that can be accessed through a URL, which allows it to provide users with context-appropriate learning content and applications. Learning Cells are learning goal oriented and can exist independently or be connected into a personalized knowledge network. The network contains metadata, aggregation models, knowledge ontology, learning content, learning assessments, learning activities, generative information, learning service interfaces and other resources.

Metadata is used to describe the attributes of Learning Cells so that they can be easily categorized, indexed and shared.

Aggregation models prescribe the inner components and connection modes of Learning Cell. In contrast with Learning Object, Learning Cell adopts a semantic-based network aggregation model in which different components dynamically connect with Learning Cell to form a network. Different learning resources can be aggregated into a Learning Cell, and different Learning Cells can be aggregated into larger-scaled knowledge groups or knowledge clouds.

Knowledge ontology describes the basic concepts and inter-concept relationships of related knowledge, which are used to construct effective aggregation models and promote the aggregation of Learning Cell components and the dynamic connection of Learning Cells containing similar content.

Content is the main component of a Learning Cell. Learners use content to obtain learning resources, codify knowledge and reconstruct long-term memory cognition. Content needs to have specific subjects and goals and to be independent and complete, even with small granularity.

Assessment is used to examine how learners grasp learned knowledge and to adjust learning strategies according to the assessment results. Learning Cell records all of a learner's interactive information and forms assessment reports after performing information analyses.

Activities promote deep interactions between learners and content; they are process oriented and enable the sharing of learning processes, strategies and activities.

Generative information is generated during the process of using Learning Cell; it contains user information, interaction information, Learning Cell revision history and so on.

Multiple formats indicate the different forms in which Learning Cell is available, including http format, e-book format, knowledge map format and video or audio format. These formats allow Learning Cell to be displayed on different terminals in a suitable way. Different formats are automatically transformed and stored at implementation.

Service interface is the primary channel of information exchange between Learning Cell and the cloud-computing environment. It defines the interface both to acquire and update process information when learners perform learning activities through Learning Cell and to update the inner components and structure of Learning Cell, making Learning Cell generative.

The cloud storage architecture embodies the importance of distributed computing and cloud computing to learning technologies. Future learning resources would not be simply deployed from a centralized inner server but distributed and connected around the world.

3.3 Core Features of Learning Cell

Learning Cell retains the accessibility, adaptability, affordability, durability, interoperability and reusability of Learning Object but has, in addition, the following five unique properties:

(1) **Openness:** Open learning resource provides not only open access but also open content. Unlike the traditional static and closed-resource organization model, Learning Cell is open and based on a dynamic resource structure. Learning Cell allows resources to be updated with to usage information, to grow by absorbing valuable online content such as Gadget, to interact with the external learning environment and to be integrated with learning activity designs. Each Learning Cell is equipped with a learning system service interface, allowing the learning process to be traced and information to be exchanged between Learning Cell and the runtime environment. Unlike RTE in the SCORM model, the service interface of Learning Cell can be used not only by its host server but also by distant systems through API, which facilitates activity sharing and the creation of an education cloud for dynamic content.

(2) **Evolvable:** Traditional learning content is static and difficult to update. SCORM course packages can split and recombine content but do not support content revision. Learning Cell makes learning content evolvable because it updates content according to the feedback it receives during the learning process. Based on the idea of Web 2.0, learning content is no longer generated by a few professionals but is generated and updated by public users and connected via a network. Unlike Learning Object, Learning Cell saves not only predefined course content, exercises and activities but also information generated during the learning process, such as submitted work, annotations on learning content and learning records. Revisions to learning content are also recorded to reflect the evolving process of learners and Learning Cells. By recording this generative information, Learning Cell can satisfy the various dynamic and personalized demands of learners by adjusting content and the content's structure, adapting it to the changing learning environment.

(3) **Cohesive:** Learning Cell is cohesive, organizing all elements of the learning process into an orderly whole. The "gene" of a Learning Cell is formed according to an ontology-based knowledge structure and aggregation model, which controls the evolution and development of each Learning Cell.The most important distinction between Learning Cell and Learning Object or SCORM-based online courses is the application of semantic network and ontology technology, which makes Learning Cell resemble an organism; it grows and evolves under the control of an internal "gene". Except when it exists as an independent and complete learning unit, each Learning Cell could serve as a node in resource networks and could connect with other nodes according to certain rules. Learning Cell supports the semantic-based network aggregation model, which is different from the hierarchical aggregation model. It can not only aggregate different learning materials into Learning Cells but also aggregate different Learning Cells into even bigger Knowledge Groups or Knowledge Clouds.

(4) **Social:** Because learning content is infused with the wisdom of all learners, the combination of physical resources and people would create a dynamically evolving and developing social cognitive network. Learners could acquire not only existing knowledge but also learning methods and knowledge acquisition channels. Learning Cells include not only materialized learning resources but also interpersonal networks generated during the evolution process. Learning Cells can be regarded as intermediaries between learning channels and social wisdom. On one hand, Learning Cells record and trace the learner information related to a learning resource, generating learner group space about the resource; on the other hand, Learning Cells automatically connect to similar Learning Cells, combining each other's learner group space and thereby achieving high-level sharing of the whole learning network system. Learning Cells connect humans through learning content and generate a social cognition network in ubiquitous learning space

(5) **Context Aware:** The core feature of u-Learning is its context awareness. It can adapt the learning services to the learning contexts; in other words, it can perceive users' demands using intelligent learning devices and offer the most suitable learning modes and services. To realize such a learning model, we must improve the perception ability of learning terminals and re-design the aggregation model to allow learning resources to adapt to different contexts. The context awareness of learning resources lies in the following two aspects: 1) intelligent adaption to learning terminals and 2) adaptability of learning content. When learners can obtain resources according to their actual needs in the most appropriate way, they are learning in context.

4. IMPLEMENTATION OF LEARNING CELL

Learning Cell operates independent of a specific supporting environment—Learning Cell System (LCS). The functional model of LCS is shown in Figure 3. Its main functions are Knowledge Group (KG), Knowledge Cloud (KC), Learning Cell (LC), Learning Tool (LT), Personal Space (PS) and Learning Community (LCm).

The LC function assembles all of the Learning Cells in the environment. Each Learning Cell is a resource entity; it can be a lesson or a knowledge point. A Learning Cell contains not only learning content but also learning activities, KNSs, semantic information, generative information and multi-format. A Learning Cell can also be an independent learning resource used by learning communities; different learning cells on a related subject can be gathered into a knowledge group. Learning Cells can introduce related assistant learning tools to support u-Learning. Learning Cells are available in multiple formats, such as web pages, e-books, concept graphs and 3D models

The KG function assembles all of the knowledge groups in the environment. Each knowledge group consists of learning cells on related subjects. For example, a course can be a knowledge group and each lesson or knowledge point in the course can be a learning cell. When users access the knowledge group, they can find all of the learning cells related to the course.

The KC function aggregates multiple knowledge groups. Different knowledge groups are connected via semantic relationships. In a knowledge cloud, users can easily find all of the knowledge groups related to their subject.

The LT function assembles all of the personalized learning gadgets. In LT, users can not only preview or save gadgets but also upload gadgets. All gadgets conforming to Open Social standards can be integrated into LT. These gadgets can be used by learning cells, knowledge groups, personal space, and learning communities. For example, to enhance learning efficiency, some gadgets, such as translating gadgets, can be integrated into the learning content during the content creation or editing process.

The LCm function assembles all of the learning communities in the environment. A learning cell is a collective learning environment (CLE) in which community members communicate, collaborate or share with each other. Community members can publish a notice, initiate a discussion, share interesting resources and initiate learning activities. Learning communities are related to LC, KG and LT, and related learning cells, knowledge groups and knowledge tools can be introduced into learning communities. In addition to learning communities, all users have their own personalized learning environment.

PS is the personal learning environment (PLE) of each user, containing functions for personal resource management, friend management, schedule management, gadget management, and personalized learning recommendations. In personal space, users can post basic personal information, manage (create, collaborate and subscribe to) interesting learning cells and knowledge groups, and select recommended learning resources.

5. PRACTICAL APPLICATIONS AND EVALUATION

Learning Cell System (LCS) is an open knowledge community developed for u-Learning. It supports collaborative knowledge editing, knowledge aggregation and evolution, multiple-level interaction and multi-dimensional communication. Specifically, LCS allows the orderly evolution of resources, facilitates shared cognition networks and the collaborative construction of ontologies and provides open service tools. LCS can be accessed at http://lcell.bnu.edu.cn. Since it was inaugurated in May 2011, 7579 users have registered, 12068 Learning Cells have been created, 80 learning applets have been generated, 1230 knowledge groups have been formed, and 84 learning communities have been formed (as of Jan. 25, 2013).

5.1 Practical Applications

We carried out two practical applications of LCS. The first application was designed to support e-Learning for graduate students and the second to support regional collaborative teaching research for primary and secondary school teachers.

In the e-Learning use case, a course was given to 25 graduate students through LCS, and the process is shown in figure 4. The learning is based on course knowledge construction and social cognition network

sharing, integrated with collaborative resource creation, learning activities, personalized assessments, on-line communities and mini-annotations.

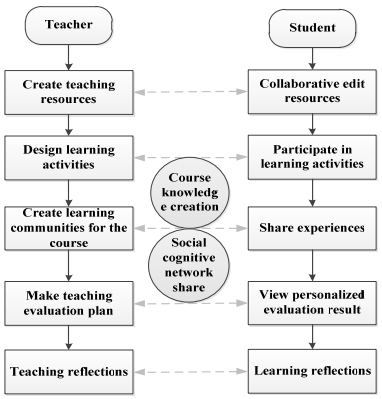

Figure 4. E-Learning process based on LCS

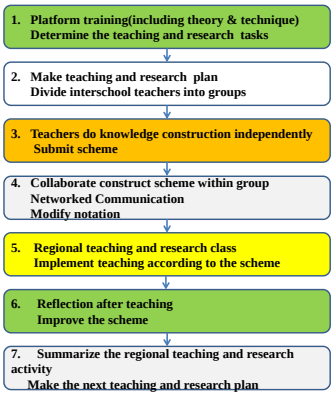

Figure 5. Regional collaborative teaching research process based on LCS

In the regional collaborative teaching research use case, teachers can share experience with each other through LCS. The director can set several knowledge groups on the focused subjects, and invite related teachers to collaborate on the research. Meanwhile, learning communities can be set up to encourage teachers to share their resources, knowledge and experience. The application was performed in Feixi County, Anhui Province, with 50 participating teachers in 10 schools. The collaboration process is shown in figure 5.

5.2 Evaluation

In the above two case studies, investigations were carried out to determine the LCS's usability and user attitudes.

The usability investigation was based on an SUS tool developed by John Brooke (Brooke, 1996), and the questionnaires were published using a professional investigation platform (http://www.sojump.com/). Fifty users participated in the investigation. The result shows that 68% of users felt confident using LCS, 26% of users felt neutral, and 6% of users felt unconfident and were not willing to use the system. Generally speaking, most users had positive attitudes toward LCS. Further investigations indicated that unconfident users felt that LCS was too complicated.

User attitude investigations was carried out on the teachers involved in the collaborative research case study. Twenty-five questionnaires were sent out by email and 23 (92%) were returned. The result shows that 82.61% of teachers liked LCS-supported collaborative research, and 8.7% of teachers disliked it. Further investigations indicated that some teachers felt LCS was too complicated to use without additional usage guidance.

The above investigations reveal that most users feel that LCS is acceptable but believe that some problems still exist. In the future, we will simplify LCS operations and perform more and deeper investigations on LCS application.

6. CONCLUSION

The organization of learning resources is a fundamental factor of seamless learning environments. Based on Learning Object, this paper proposes a new learning resource organization model, Learning Cell, which provides a theoretical and practical basis for resource organization in future u-Learning.

To highlight the features of Learning Cell, comparisons of Learning Cell and Learning Object are made in Table 1.

Table 1. Comparisons of Learning Cell and Learning Object

	Learning Object	**Learning Cell**
Background	To resolve the problems with disorder, isolation, sharing and low retrieval efficiency associated with e-Learning resources; introduces the idea of object-oriented computing	With the emergence of semantic webs, cloud computing, ubiquitous computing, the paradigm of e-Learning needs to change
Concept and Features	Re-usable, accessible, affordable, durable, and interoperable	Generative, open, connective, social, evolutionary in development, cohesive, intelligent, and miniaturizable
Underlying Theory	Behaviorism and cognitive learning theories	Social constructivism and situational cognitive theories
InformationOrganization	Other-organized; one-way transmission of information	Self-organized; two-way transmission of information
Information Model	Learning content focused	Learning content in combination with learning activities, generative information, KNS and semantic ontology
Repository structure	Centralized repository	Cloud storage model
Quality Control	Rely on experts	Based on social trust and knowledge ontology mechanisms
Sharing Scope	Low-level content sharing	High-level intelligence sharing, including learning activities, learning tools, interpersonal relationships and generative information

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LINGOBEE – CROWD-SOURCED MOBILE LANGUAGE LEARNING IN THE CLOUD

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ABSTRACT

This paper describes three case studies, where language learners were invited to use "LingoBee" as a means of supporting their language learning. LingoBee is a mobile app that provides user-generated language content in a cloud-based shared repository. Assuming that today's students are mobile savvy and "Digital Natives" able to engage in language learning autonomously using technology, initial studies were conducted with little or no intervention by the language teachers. However, the support and guidance provided within a teacher-led context can impact positively on learner engagement and use of LingoBee. The case studies confirm this hypothesis. This paper answers the research question: Does the level of the support and guidance, pedagogical approach and prior learning impact on learners' engagement and use of LingoBee?

KEYWORDS

Mobile Language Learning, User-generated content, learner-centred, language and culture, Crowd-sourcing, Cloud computing

1. INTRODUCTION

Mobile learning has been perceived as learning on the go, where learners may engage in activities that enhance their knowledge as they go about their daily lives. The early views of mobile learning focused on technology that is mobile, e.g. (Quinn 2000), have evolved to learning anytime, anywhere and anyhow (Sharples 2006), fostering a new culture of thinking and learning. Mobile Learning is undergoing an evolution "from a position of where 'delivery' of learning was paramount, to current thinking which encompasses a learner-generated content perspective" (Kukulska-Hulme 2009). New technologies and technological trends continue to influence mobile learning. For example, Cloud Computing is seen as an economic solution to provide students and teachers free and low cost alternative storage and computing power (Branon, Wolfenstein et al. 2012). Clouds have been described as "a classroom without walls, instructions or curricula" (Koulopoulos). Examples of a few applications that connect Mobile Learning to the Cloud are available in the literature; Revu4u (Review for You), is designed to help students prepare for Advanced Placement (AP) tests, which enable high-school students to acquire college credit in various subjects (Branon, Wolfenstein et al. 2012). A model of Mobile Learning based on cloud computing is proposed in (Li 2010), where cloud computing is considered a "bridge between teachers and learners", teachers producing and publishing learning material. Another technological development that has been considered in the context of mobile computing is crowd-sourcing, e.g. (Satyanarayanan 2011). While these technological trends have been discussed in the literature as influences on Mobile Learning, little has been reported on approaches that were not teacher-led (Kukulska-Hulme 2009). There is little or no evidence of learner-centred mobile learning activities, particularly based on learner-generated content.

Cloudbank, a mobile (Android) app is designed to enable advanced language learners to collect and describe multimedia language and culture-related content they came across in everyday life within their target language culture (Pemberton, Winter et al. 2009). Cloudbank used crowd sourcing to collect language related content in a shared repository "in the cloud". Developed from Cloudbank, LingoBee is a crowd-sourced mobile app to support situated mobile language learning and to help the learners with linguistic and

cultural diversity (SIMOLA 2012). Ideally, technologies such as LingoBee should be complementary to the activities in formal language learning classes. We envisaged that activities around LingoBee in the informal learning arena and the content generated would bring the learners' interests into the classroom, thus bridging the formal and informal learning arenas and enhancing the learning support for the language learners. The main research question for this paper is: Does the level of the support and guidance, pedagogical approach and prior learning, impact on learners' engagement and use of LingoBee? In this paper, we describe three case studies conducted in three European countries, where language learners were invited to use "LingoBee" as a means of supporting their language learning.

This paper is organized as follows: Section 2 provides a brief description of LingoBee; Section 3 describes the three case studies; Section 4 outlines initial results of the case studies; Section 5 discusses how the teacher-led activities can motivate learners and Section 6 summarises the paper.

2. LINGOBEE MOBILE APP

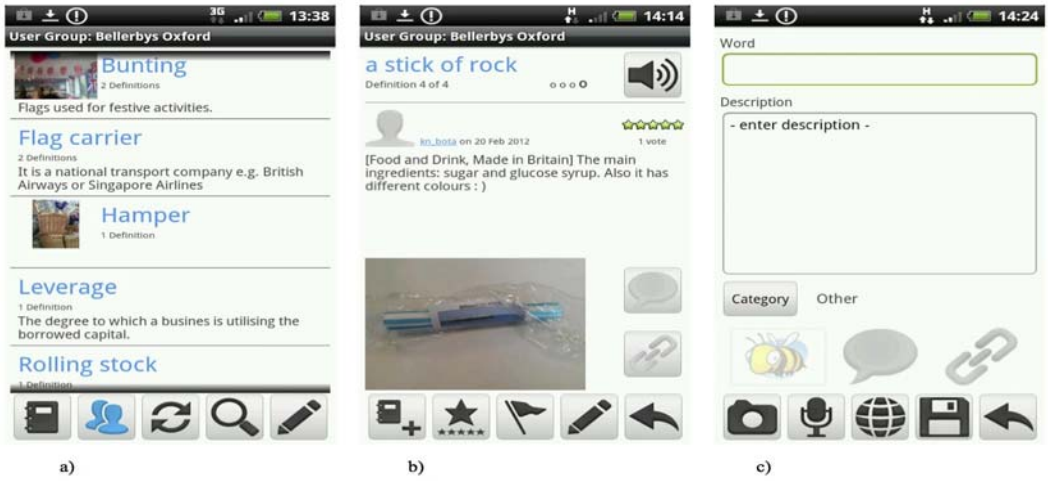

Figure 1. LingoBee functionality. a) Crowd-sourced repository; b) An entry; c) Editor to enter a definition

LingoBee is based on the ideas of situated and contextualized learning. It is designed to capture language elements that learners come across in their everyday lives, whenever and wherever. Ideas of crowd sourcing and social networking are used to collect, share and annotate the contributions of all learners in a shared online repository as shown in Figure 1a). Language learners are able to add entries, words or phrases, to the repository which can be accessed and downloaded as favourites by other LingoBee users, see Figure 1b), which shows a description of a phrase by a language learner containing a picture, and 1c) where the user can enter new descriptions to the shared repository. Learners can add new descriptions to existing entries and rate existing descriptions; e.g. in Figure 1b) the entry "a stick of rock" had four descriptions and users have given it a five star rating. Language articles are co-constructed as students add additional photos, web links and audio as part or full entries to build meaning together.

3. CASE STUDIES

Based on findings from earlier studies of Cloudbank (Pemberton and Winter 2011) and (Petersen, Sell et al. 2011), the first studies of LingoBee looked to leverage the benefits of the technology and provide a synergy between the classroom and the learners' everyday lives. Field trials were run in a number of European countries. LingoBee was initially introduced to language learners in their language classes. The teachers' involvement beyond the introduction varied as we intended to address both the perceived lack of student-led approaches in MALL (Mobile Assisted Language Learning) trials (Kukulska-Hulme 2009) and the assumption that LingoBee would be used in the informal learning arena and would foster active situated

language learning and collaboration among the students using it. Consideration was also given to the Cloudbank trials which focused on establishing student's use of the mobile app. "Students were not provided with model entries… These were conscious decisions in the evaluation design as the design team was interested in a) how students would use and appropriate the system (independent from our own views of how the system *should* be used) and b) whether the system was easy enough to understand and use without training." (Pemberton & Winter, 2011). Kukulska-Hulmes and Sheilds noted that language learners found "uses that were not anticipated by the researchers (recording each other speaking the foreign language rather than interviewing the locals...)." (Kukulska-Hulme and Shield 2006) as quoted in (Comas-Quinn, Mardomingo et al. 2009).

The three case studies presented in the following subsections represent the outcome of iterative investigations where the second studies are informed by the first. The changes made included the manner in which LingoBee was introduced, the pedagogical approach and the level of support and guidance offered.

3.1 Case 1: International Students at Unimol

This study was conducted at the University of Molise (Unimol), Italy. The 1st trial involved 10 Erasmus undergraduate Spanish students recruited on a voluntary basis from a class of 50. At entrance, they all presented similar sociolinguistic characteristics: Spanish as L1, a little English as L2, no previous knowledge of Italian and low learning motivation. This latter feature was probably due to the crossover between the two languages and the fact that they tended to socialise with other Spanish speaking friends. They attended a 40-hours face-to-face course, with Italian as lingua franca. The 2nd trial brought together 5 Erasmus students from Turkey, 1 from Spain and 1 from Portugal (all females) from a class of 13 students from Poland (4) and Spain (2). They were recruited on the basis of their motivation and of their L1 type giving preference to those with distant languages. Their entrance characteristics were different: they had Spanish/Galician, French, Chinese and good English as L2. Only one of them had studied Italian before, but they seemed more motivated. Their course was similar to the first, but the lingua franca was English in this case.

The ten students from the first trial were each given a pay-as-you-go smartphone. When they received the phone, they were provided with only basic instructions, in order not to influence their way of using it. No further support or interventions were made. Initially they took part actively in the trials, but clearly showed their main interest was the free smartphone.

For the 2nd trial, 7 students were again each given a pay-as-you-go smartphone as before. Similarly very little information was given at the beginning of the trial, but, in contrast to the 1st trial, a support Facebook group was created and several sessions on LingoBee were incorporated into the course. This change was in response to the poor outcome of the 1st trial, especially considering that the initial students were able to write in Italian from the very start of their studies. Thus, it was decided to 1) select the 2nd group according to their motivation and the L1 type; 2) provide them with the extra support of a Facebook group, (Cacchione 2011); 3) reduce their autonomy by incorporating LingoBee use into the classroom. The outcomes of the 2nd trial seem to confirm the effectiveness of these pedagogical changes.

3.2 Case 2: International Students at Study Group

This study was conducted at Bellerbys College, Oxford, part of Study Group UK. The first trial consisted of pre-university foundation students aged 18-19, with an IELTS (International English Language Testing System) score of 5.5 who were recent arrivals in the UK. The six students chosen were a diverse cultural mix: 1 Mexican/German, 1 Libyan/American, 2 Chinese, 1 South Korean and 1 Iranian.

The group consisted of students from a range of different educational and subject backgrounds brought together for the purpose of this trial. All were internet and mobile savvy, using both extensively in their social life, however they lacked the study skills necessary to use LingoBee independently. They were enthusiastic but very unreliable, often failing to attend or do the work set. This resulted in a paternalistic approach being employed by the teacher with multiple reminders sent by email and text. Originally it was intended that the trial would last 6 months with one set of students but it was decided to end this trial early and start a new one with more reliable and able students.

The participants of the second trial were motivated, internet and mobile savvy 2nd year A level students, aged between 17 & 19. They were again a mixed nationality group: 2 Chinese, 2 Vietnamese, 1 Kazakh and 1

Iranian. However they had a mixed IELTS score profile ranging from 6.5 to 8.5. The group knew each other well and most attended the same classes. The main reason for choosing the group was that 4 students had prior experience of mlearning in formal lessons and attended Accounting lessons with the teacher/researcher.

Both trials were introduced by classroom activities designed to familiarise students with the LingoBee app. This involved behaviourist principles with students completing a scavenger hunt to add specific items into the repository, followed up with tasks that included scaffolding and modelling of good practice by the teacher/researcher, (Wood, Bruner et al. 1976). Students were each given a smartphone with a contract (including data bundle, calls and texts) and supported in both trials by a course on the Virtual Learning Environment (VLE). The first group was introduced to LingoBee and attended fortnightly lunchtime lessons in addition to their academic studies. The second group was introduced to LingoBee but this time through weekly timetabled lessons in addition to their academic studies. Both groups involved in the study were asked to attend all lessons and initially given a task to complete after each lesson.

3.3 Case 3: ERASMUS and International Students at NTNU

This study was conducted at the Department of Languages and Communication at the Norwegian University of Science and Technology (NTNU). Eighteen voluntary ERASMUS students learning Norwegian during the summer participated in the study. The participants were from two different language classes. The courses were intensive, level 1 language courses, with 80 hours of teaching during three weeks. The average age of the students was between 19-25 years and the trial was conducted over two weeks. The students were not attending other classes during that period. LingoBee was not a part of the course and the students were left to use it on a voluntary basis.

The second trial was conducted with fifteen voluntary ERASMUS and International students attending university or working in Norway. It was a level 1 course; 57 hours of teaching was offered over 10-11 weeks. The average age of the students varied between 26-30yrs. The trial was conducted over eight weeks. The teacher had intended to use time during the classes to look at content from LingoBee and make it a part of the course. However, due to the reduction in the number of students during the course, the teacher was not able to use LingoBee as initially planned.

For both trials, the basic functionalities of LingoBee were introduced by a researcher and presented as a complementary technology and as a means to capture and share your own words or phases. Participants were provided with smartphones with LingoBee installed, but no SIM cards as free wireless network was readily available across the campus and city. The teachers had access to the LingoBee repository and occasionally flagged content created by the students to indicate mistakes.

4. RESULTS

For case study 1 conducted at Unimol, both trials lasted three months. The first group produced 92 entries in the LingoBee repository. Most had pictures, but only one had a web link; no audio comments were added. Only 2 multiple entries were produced. The entries covered a wide range of topics. About 20% covered cultural topics such as festivals and food; **Figure 2**a) shows an example of an entry related to food. About 15% of entries presented aspects of the private life of the students such as study and travel. About 10% was made of “specialised” entries related to the internship some of the students were doing as nurses or trainers.

The 2nd group produced 140 entries. Most entries had pictures and 16 had audio comments. There were no multiple entries. Similar to the first group, there was no direct correlation between engagement in LingoBee use and proficiency in Italian; they all passed the exam with a good score. The entries covered a lesser range of topics. About 14% covered cultural topics such as food and religion. All the other entries were about things surrounding students in their daily life (to cook, to clean, etc.); see **Figure 2**a). An appreciable reduction in the linguistic complexity of entries was observed, due to the difficulties in managing Italian.

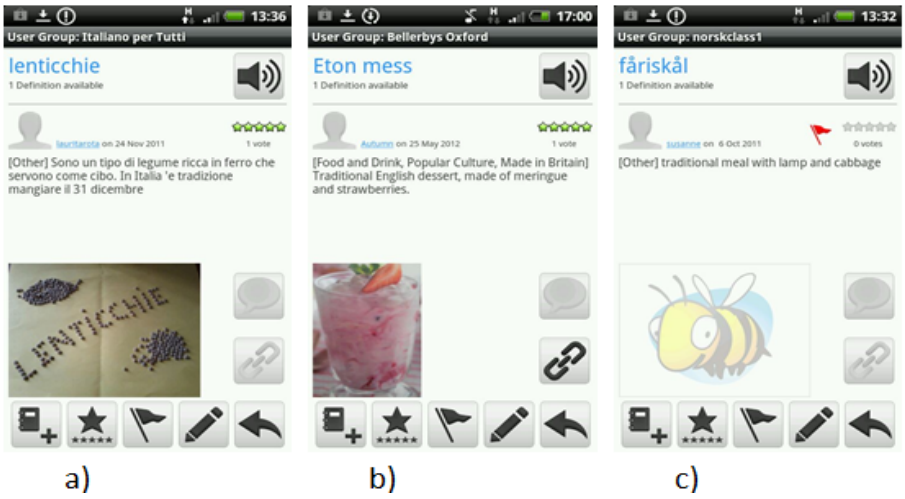

Figure 2. Examples of LingoBee entries related to food and culture

For case study 2 conducted at Study Group, both the trials lasted 14-15 weeks. The first group of students produced 207 entries in total covering a range of topics, e.g. cultural items including food and events, Figure 2b) or subject specific entries e.g. Business, Accounting or Chemistry. Almost half (115) resulted from specific teacher directed activities. The second group produced 415 entries covering a much wider range of topics than the first group; in addition to food and events, cultural items included places of interest and subject specific entries included Political and Economic terms, etc.,

For case study 3 conducted at NTNU, the first group produced 78 entries during the two weeks. The entries included simple words and expressions that appear in everyday conversation. An example that relates to Norwegian food and culture is shown in Figure 2c); note that the correct name of the dish is "fårikål". Only a couple of the entries had a picture and a few were rated by peers in the same user group. The second group produced 91 entries during eight weeks, 16 of which had pictures included in the entry. There were more entries rated than for the first group. Similar to the first group, the entries were mostly about daily life and every day things. The entries for the second group, however, appear to be more advanced and had sentences and questions consisting of 6-7 words. Some of the entries were of a communicative nature; reflecting comments and questions in normal conversations.

Table 1. Overview of the results from the case studies

	No. of entries per participant		*No. of favourites per participant*	
	Study 1	**Study 2**	**Study 1**	**Study 2**
Case 1: Unimol	9.2	20	1.4	0.125
Case 2: Study Group	34.5	69.2	1.67	13.5
Case 3: NTNU	4.3	6.1	1.39	3.01

In addition to the user-generated content itself, we have looked at the level of participation by the learners by analyzing the no. of contributions and the no. of times a user downloaded user-generated content from the cloud-based repository as their favourites. An overview of the three case studies in terms of the total number of entries and the number of entries per participant is provided in Table 1. The data shows that the number of entries per participant increased from the first to the second study, for each case study. Similarly, the no. of times a user downloaded user-generated content from the repository increased for cases 2 and 3, showing that the level of LingoBee related activities and participation increased in the second study cycle. For case 1, there is a decrease in the no. of entries downloaded from the repository for the second study. A possible reason is the fact that the first group was a little wider but, above all, was made of actual friends in daily life, who used LingoBee together and shared the content in real time. They produced less entries but in a more social way.

5. DISCUSSIONS

In this section, we will attempt to answer our research question based on observations from the case studies: Does the level of the support and guidance, pedagogical approach and prior learning impact on learners' engagement and use of LingoBee?

The second trial was designed to include LingoBee as an integral part of the activities of the course. Unfortunately, due to several dropouts from the NTNU study, this was not possible in all cases. Nevertheless, the results from both case studies 1 and 2 clearly illustrate that this change in pedagogical approach did increase the level of participation (see Table 1).

The first trial in case study 3 had participants from a two-week intensive language course who were not engaged in other studies so we were interested to see if this scenario created a difference in engagement and participation. An interesting observation was that the number of entries per participant per week was greater in the first trial than in the second, although the participants of the first trial were volunteers and LingoBee was not presented as a part of the course. This implies that the participants in the intensive course, not studying other subjects, were able to engage more in LingoBee activities than the participants of the second trial, who appeared to be busy with other activities, which often took priority over language learning.

The second trials in both case studies 1 and 2 had more active involvement from the teachers. "Second language acquisition is best promoted through the utilization of tasks focusing the learner on meaning" (Kiernan and Aizawa 2004), as quoted in (Chinnery 2006). Case study 2 included activities such as a scavenger hunt and a walking tour of the city using LingoBee as shown in **Figure 3**. The second group had a number of LingoBee lessons before the walking tour, they all enjoyed it very much and one commented that it helped him to understand when and where he could use LingoBee. *"Since April/May I used LingoBee more frequently for taking pictures after the lesson with the walking tour used pictures more out and about."*

Figure 3. LingoBee activities: a walking tour of the city

In case study 1, it was observed that the first group was not very motivated in learning Italian. However, the second group was selected based on their level of motivation and this may have been a factor in their increased participation. In addition, a Facebook support group was created as an additional support outside of the classroom. This was initiated by one of the Polish students to communicate with other students in the Italian L2 course (the group in fact is named "Corso di lingua italiana"). The teacher/researcher joined the group and also used to provide notices about the lessons. Only a few posts related to LingoBee, however it seems to have had a positive impact on the use of LingoBee by boosting the overall guidance and support available for the students. Figure 4 shows activities on the Facebook support where the discussion was related to LingoBee.

Figure 4. Facebook support in case study 1, LingoBee related activity

Case study 2 identified that although the participants were internet and mobile savvy and may have had prior experience of mobile learning, some needed help to adjust to mobile learning and to see the benefits of this approach. Some of the students came from more traditional educational backgrounds and have found it difficult to adjust to this new approach. It is a 'myth to expect all young learners to automatically understand new technology' (Attewell, Savill-Smith et al. 2009). Therefore, how LingoBee was introduced and the level of support provided both at the beginning and throughout the trial played a role in the level of participation of the students. Both case studies 1 and 2 had observed this and adapted their second trial accordingly. This was not considered in case study 3. Also, from pre-intervention questionnaires, it was evident that the participants used online dictionaries and Wikipedia as a means to support their language learning activities. However, looking at the results and the level of participation, it appears that LingoBee had a higher threshold to gain acceptance and regular use.

The first point at issue is if the support and guidance provided within a teacher-led context can impact positively on learner engagement and use of LingoBee. The case studies seem to confirm this hypothesis, in line with recent investigations indicating there is a close relationship between learner autonomy (and effectiveness) and the guidance students receive while learning (Reinders and White 2011). But this seems to contradict the assumption that mobile devices are the ideal enabler for learner autonomy intended as personal choice (Godwin-Jones 2011): if mobile phones are the perfect environment for autonomous learning, why is there (still) the need of a teacher-led approach? Isn't it enough for Digital Natives to be given a smartphone and special purpose software to engage in a challenging and effective learning process? As the title of the new study by Higher Education Strategy Associates suggest, 'if students are Digital Natives, why don't they like e-learning?' (Higher-Education-Strategy-Associates 2011). The question addressed is crucial: we teachers and researchers as digital immigrants (Prensky 2001), have to consider that it is indeed a 'myth to expect all young learners to automatically understand new technology' (Attewell, Savill-Smith et al. 2009), they need to be trained to understand the value of the devices, their potential and the relevance of their uses for their learning. In fact, 'autonomy is natural to human learning, but does not come naturally' (Reinders and White 2011). We need, in an outward paradoxical way, to teach them not to be taught, i.e. to become autonomous learners.

6. SUMMARY

This paper describes three case studies conducted in three European countries, where language learners were invited to use "LingoBee", a mobile app, as a means of supporting their language learning. LingoBee uses crowd-sourcing to gather user-generated language related content in a shared repository or a cloud. Today's students appear to be mobile savvy "Digital Natives" and avid users of mobile apps and other technologies to obtain the support they need for learning as well as their daily activities. Assuming that they would engage in language learning autonomously using LingoBee, studies were conducted among international students learning a language. The first cycle of studies observed that the level of engagement by the students were not as expected. Assuming that the support and guidance provided within a teacher-led context can impact positively on learner engagement and use of LingoBee, further studies were conducted where the teachers adapted their pedagogical approaches and the level of support provided to the students based on the experiences from their first studies. The case studies show that the second studies, where there was more involvement by the teachers, provided a better result. In this paper, we have included examples of activities and support that can enhance the language learning experiences of the students.

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MEDIA CREATION AND SHRING IN INFORMAL, SITUATED, AUTHENTIC MOBILE LEARNING FOR LOCAL CULTURAL DIVERSITY INVESTIGATION

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ABSTRACT

New media shape the intensity of intercultural contacts not only through content consumption but also through content creation with modern technologies. Enabling citizens to participate in the content exchange via the Web 2.0 paradigm (audiences as both media consumers and media creators, which is prevalent in modern online services) results in greater than ever before heterogeneity of modern societies. This study demonstrates an application of portable multimedia devices (smartphones) for content creation and sharing in the context of situated, in-the-field cultural diversity investigation aimed at intercultural competence development in the context of local environment, i.e. a location familiar to students. The paper shows how m-learning can be employed to create new forms of acquiring knowledge by application of mobile devices in Linguistic Landscape examination of multilingualism. The application is shown from the pedagogical perspective of situated, authentic, informal learning tasks conducted in the framework of connectivism. This study presents a ready-made scenario of m-learning activities that demonstrate that cultural awareness is often biased by personal perspectives and stereotypes. Conducting such activities results in the change of learners' attitudes toward other cultures, which is a sound staring point for further intercultural competence development.

KEYWORDS

Mobile learning, intercultural competence development, situated learning, informal learning, linguistic landscape

1. INTRODUCTION

Current pace of globalization demonstrates that cultural diversity carries an enormous inherent potential for progress and expansion in the future. The *development of intercultural competence* has already been perceived for some time (LACE 2006, CEDRPC 2006, RHLEFM 2008, CEDEFOP 2009) as a basic condition for peaceful and prosperous coexistence at both the local and global level. The ability to deal with cultural diversity is no longer required only of business professionals working in international settings, but has become a key qualification required of individuals to act productively in the modern world. This observation has already been confirmed in research (Deardorff and Hunter 2006; Hulstrand 2008) pointing out that the ability to handle interaction in culturally diverse environments is a major skill employers seek. As put by Spitzberg and Changnon (2010, p. 4.) "With ample opportunities for employment overseas, it becomes important for internationally competitive business to hire interculturally competent employees, if only for the future success of the business."

Cultural diversity is manifested through linguistic presence. The inextricable link between cultural and linguistic diversity is stated in the *Universal Declaration of Cultural Diversity* (UNESCO 2001) and the *Convention on the Protection and Promotion of the Diversity of Cultural Expressions* (UNESCO 2005). The linguistic, hence cultural, diversity can be studied efficiently with the Linguistic Landscape methodology, which is a rapidly growing area of research that has recently gained enormous popularity in a variety of disciplines. It can be essentially defined as systematic examination of written displays of minority languages in the public space (Shohamy and Gorter 2009).

The research discussed in this paper is based on Byram's assertion that "people who live in a particular country do not know intuitively or otherwise the whole of the culture of that country because there are in fact many cultures within a country" (Byram et al. 2002, p.17). For that reason, the exploration of cultural

diversity discussed in this study is situated in the context of environment local to the participants. This paper demonstrates how application of mobile learning activities conducted with proper interaction, collaboration, and interpretation of results contributes to the development of intercultural competence.

2. INFORMAL, PERSONALIZED, SITUATED MOBILE LEARNING

The term *Mobile Learning* (m-learning) is associated with learning delivered by mobile (handheld) devices, such as smartphones, tablets, portable music players, etc., usually connected wirelessly to the Internet. Although those devices are central to conducting mobile learning, such technocentric conceptualizations has been recently viewed (Kukulska-Hulme 2010, JISC 2011) as rather superficial, since various definitions of mobile education in terms of utilized devices seem to be constraining and limited to current technological instantiations. At the pace of current technological innovation they quickly become obsolete before gaining widespread use in education.

Other proponents of mobile learning (Winters 2006, Sharples 2007) conceptualize it in terms of the mobility of learning. This is a highly important aspect of m-learning, since extending learners' mobility changes both the nature of learning, and the variety of ways in which it can be delivered. However, as noted by Traxler (2009, p. 15) the nature of learning mobility can be viewed differently by different learners. For some people it may be associated with reading with a laptop computer on a train while commuting to school; for others it may be hands-free listening to audiobooks or podcasts while exercising, etc.

Because the above interpretations somehow limit the understanding of m-learning, it has become apparent that the full conceptualization of m-learning is still emerging, and the current distinction between *m-learning* and *e-learning* is somehow blurred. As noted by Traxler (2009, p.14) this distinction may be temporary, since with the advent of portable devices, wireless connectivity, and extended battery life, these two concepts may soon merge into one. Consequently, Traxler (Ibid.) proposes a definition which views mobile learning from the underlying learner experience. It distinguishes m-learning from other forms of electronic education by putting emphasis on ownership, informality, mobility, and contexts that will always be inaccessible to conventional tethered e-learning.

As pointed out by Kukulska-Hulme (2010, p. 181), m-learning is more specific that e-learning in its focus on mobility which greatly extends the control of time and location that learners have over their learning activity. This substantially broadens learning opportunities in comparison to the traditional desktop-bound e-learning. Because mobile learning is closely related to *e-learning* as well as *distance education*, any attempts to develop its definition and implications must take into account that it occurs differently in different educational contexts. Kukulska-Hulme and Traxler (2007, p. 182) undertook an analysis of extensive body of research conducted in different learning contexts (including a large number of pilots, case studies, and trials) to specify emerging categories of mobile learning. One distinguished category involves the *informal, personalized, situated mobile learning* which occurs when "mobile, wireless and handheld technologies, are enhanced with additional functionality, for example, location awareness or video-capture, and deployed to deliver educational experiences that would otherwise be difficult or impossible" (Ibid.). This study focuses on this specific category, taking into consideration its particular features in the context of cultural diversity examination with the linguistic landscape methodology.

Among different characteristics of mobile learning one that is particularly significant to this study is the aspect of *situated learning*, as proposed by Lave and Wenger (1991). It implies that in the course of educational activity learning takes place in appropriate and meaningful contexts. Because situated mobile learning supports context-specific and immediate learning that situates and connects learners (Traxler 2009, p.18), this aspect of m-learning is perfectly suited to the linguistic landscape methodology. This enables students to act as apprentices in the process of hands-on exploration of local cultural diversity, which results in their increased participation in the learning community.

Furthermore, this study puts a strong emphasis on *informal education*, as distinguished by Livingstone (1999, p.4), which can be essentially defined as learning activities involving the pursuit of knowledge or skill which occurs without the presence of externally imposed curricular criteria and is conducted under the guidance of institutionally-recognized instructor. This study demonstrates the transition from the *knowledge production* paradigm to the *knowledge navigation* paradigm (Brown 2005), where formal and informal learning techniques are mixed and the traditional teacher's role changes to that of a coach and mentor. As

emphasized by Vavoula and Sharples (2008), blurring of boundaries between formal and informal education adds certain value, because in some learning situations it makes sense to incorporate both elements of formality and informality.

Another attribute of mobile learning particularly relevant to linguistic landscape investigation is the aspect of *authentic learning*. It implies that learning should be based around authentic tasks that enable students "to explore, discuss, and meaningfully connect concepts and relationships that are relevant to the real-world and are meaningful to the students" (Donovan et al. 1999). As shown in this study while investigating the linguistic landscape of their local city students are directly involved in the exploration and inquiry of cultural diversity, by which they gain opportunities to pursue meaningful problems and become engaged in social discourse.

Finally, the application discussed in this paper falls into the pedagogical framework of *connectivism* (Siemens 2004) where learning is focused on connecting specialized information sets collected by individuals involved in the learning process. "The connections that are created in this process enable learners to gain new knowledge, which is more than their current state of knowing." (Ibid.) In this study the experience of individuals involved in the investigation of cultural diversity of their city is fed back into a shared linguistic landscape to create new knowledge that provides further learning to all students involved in the process. This cycle of knowledge development enables learners to gain new knowledge through the connections they have formed while examining the local cultural diversity with the linguistic landscape methodology.

3. LINGUISTIC LANDSCAPE

The concept of *Linguistic Landscape* (LL) was initially used in sociolinguistics by Landry and Bourhis (1997, p. 25), who described it as follows: "The language of public road signs, advertising billboards, street names, place names, commercial shop signs, and public signs on government buildings combines to form the linguistic landscape of a given territory, region, or urban agglomeration." This description is nowadays regarded (e.g. Gorter et al. 2012) as the reference point for many of current developments in this field. Linguistic Landscape, i.e. counting languages on written signs on the streets inside and outside various types of buildings and subjecting them to different levels of linguistic analysis, often embraces also qualitative data in the form of background interviews and thorough examinations of collected language samples. Combined with other sources of data, such as information on spoken language traditions of a region or language legislation, the systematic analysis of linguistic landscape becomes more comprehensive as it takes into account ways in which the linguistic landscape reflects language demographics, attitudes and policies (Gorter et al. 2012, pp. 3-4). In this manner linguistic landscape research contributes to a better understanding of the dynamics of cultural diversity changes in a particular area.

An important aspect of linguistic landscape research is the *minority language* in the focus of attention. It can be approached from different perspectives. One major distinction made by Gorter (2006, pp.5-6) concerns *autochthonous* (or traditional) and *migrant* (or new) minority languages, although as stressed by Extra and Gorter (2008, p. 9) these groups have much more in common than is usually noticed. Another important distinction (Gorter et al. 2012, p. 6) is the difference between *unique* minority languages, i.e., languages which exist only as minority languages (such as Basque or Welsh), and *local-only* minority languages which are majority languages in another state (such as Polish in Lithuania). As emphasized by the above cited authors, such distinctions are not always easily applicable in real-life situations, hence remaining arbitrary to some extent.

Another central area of discussion in the current linguistic landscape research concerns the unit of analysis. Although all LL studies take into consideration language sings, there are different views on what should be considered a valid language sign for a linguistic landscape. Although Backhaus (2007, p. 66) defines it quite broadly as "any piece of written text within a spatially definable frame", traditionally most linguistic landscape studies are based on static linguistic signs. As argued by Gorter (et al. 2012, p. 6) this perspective may be somehow outdated nowadays when, especially in urban regions, we are often surrounded by flat screen displays and other dynamic visual signs that have recently gained enormous popularity.

An important position in LL studies is occupied by research of *multilingualism*, which in the era of dynamic globalization and localization is often manifested through the presence of minority languages (in all senses discussed above) in the linguistic landscape of a given region (Gorter 2006, pp. 81-82). Since

linguistic landscape is an entirely human-made phenomenon it evidently pertains to cultural reality of a given location. For that reason, it can be used to investigate how linguistic landscape reflects language demographics, use, attitudes, and policies of a given location to discover its underlying cultural diversity. This makes a valid starting point for the cycle of intercultural competence development.

4. INTERCULTURAL COMPETENCE DEVELOPMENT

As summarized by Spitzberg and Changnon (2010, p. 9.) terms such as *intercultural competence*, *intercultural effectiveness*, and *intercultural adaptation* trace back to the 1970s and 1980s. At that time various efforts were undertaken to develop a list of intercultural competence characteristics. They mainly showed that any comprehensive measures applied in this context should be multidimensional in nature. Despite numerous calls for intercultural competence development, the full conceptualization of *Intercultural Competence* (IC) has not been completely agreed between various disciplines, terminologies, and theoretical frameworks. This observation inspired Deardorff (2004, 2006) to conduct a comprehensive study in order to identify the components that should be incorporated in this notion. Her outcome-based definition views intercultural competence as "the ability to communicate effectively and appropriately in intercultural situations based on one's intercultural knowledge, skills and attitudes" (Deardorff 2006, p. 247). It has achieved wide consensus among intercultural scholars.

Deardorff's definition is accompanied by an extensive, multidimensional, cyclical model that visualizes development of intercultural competence from the personal to interpersonal level of interactions. The model shows a continuing process of intercultural competence development, which is viewed as the movement from individual *internal outcomes*, characterized by personal intercultural reflection and attitudes, to *external outcomes* which result in effective interaction in intercultural contexts. Altogether Deardorff's study (Ibid.) identifies 22 elements of intercultural competence, including knowledge, skills, attitudes, comprehension, tolerance, etc., which were agreed upon by the international scholars and professionals in the field.

The model presumes that the development of IC skills is an on-going learning process that involves, among other crucial elements, curiosity and discovery (Ibid., p. 255) which are necessary to transform one's attitude, knowledge and skills to become sensitive to cultural differences in situations where language functions as a means of interaction and communication. This is congruent with Byram's view (2001, 2002), which puts the *skill of discovery and interaction*, i.e. "the ability to acquire new knowledge of a culture and cultural practices and the ability to operate knowledge, attitudes and skills under the constraints of real-time communication and interaction" (Byram et al. 2002, p. 14), among basic skills involved in intercultural competence development

Therefore, a fundamental element in intercultural competence development is an opportunity to *discover and evaluate* as well as to *analyze and interpret* various phenomena that are related to other cultures. The acquisition of intercultural competence, including *knowledge, comprehension*, and *skills* takes place through discovery, interaction, and interpretation of other cultures manifestations. They form a key component in the practice of intercultural competence development.

5. M-LEARNING ACTIVITIES

This study demonstrates an example of mobile learning activities intended to develop intercultural competence through empirical discovery, analysis, and interpretation of a linguistic landscape. The investigation was conducted in the context of local environment, i.e. a location familiar to participants, at the Institute of English Studies of the University of Lodz in October 2012. The group that took part in the research consisted of 20 students of English Philology in the final year of their MA program. Lodz is the third-largest city in Poland located in the central part of the country. It has a population of over 700,000 citizens. Over the last few years, the city has seen many foreign companies opening offices in the region. Moreover, Lodz is an important academic center with three major state-owned universities, and a number of smaller centers of higher education. (Wikipedia: Lodz). Consequently, the city centre could be reasonably expected to show some visible traces of cultural diversity in its linguistic landscape. The location for cultural diversity exploration was limited to 700 meters long region of the main Piotrkowska street restricted by two

cross-streets (Pilsudskiego and Struga) at the opposite location ends. The students' relative familiarity with that location helped them in mapping spotted language signs, and prevented them from wandering off the exploration site.

The object of study concerned only migrant minority languages whose visibility stems from mixing different cultures in modern Europe. Consequently, exploration efforts dismissed any historical dialects existing in the region. The participants were encouraged to look for all foreign language signs that they could possibly recognize. As advanced philology students they were expected to have a fairly extensive knowledge of various languages and cultures. The unit of analysis for LL methodology in the research was specified quite broadly as "any visible foreign language sign that could be spotted", including both outdoor and indoor locations in the vicinity of the street. The participants were encouraged to look inside cafés, restaurants, shops, etc. to broaden their opportunities for discovering linguistic diversity in a short period of time that could be devoted to the exploration.

The data collection was conducted with a simple, effective methodology. Pictures of spotted language sings were taken with cell phone cameras, and their locations with short descriptions were carefully noted by students. It should be emphasized that only personal mobile phones were used for picture taking, therefore no additional technical equipment is necessary to conduct similar activities in other contexts. Geotagging of pictures, i.e. automatic addition of geographical location metadata to photographs, was not used for mapping of linguistic signs in this particular study (because some participants had older cell phones without this functionality), but potentially it can be applied to achieve the same results with less trouble.

Transfer of foreign language sign pictures and their respective locations to a single, commonly shared linguistic landscape was achieved with the use of *Google Maps* – higly popular web service provided free of charge by Google. It enables marking locations on electronic maps, and what is particularly importantly in this case, allows for accompanying each marked location with a picture. It also allows for public sharing of such maps.

The activity session was divided into two stages which altogether took 4 teaching hours. The first part was devoted to the initial tutoring and instruction, which was followed by data collection (2 teaching hours). The remaining time of the session was devoted to picture transfer and analysis of the emergent linguistic landscape. Both at the beginning and at the end discussion sessions were held. The initial discussion focused on predictions on the cultural diversity of Lodz. It was used to identify students' starting cultural awareness. The final discussion was based on analyzing the emergent linguistic landscape. The participants had an opportunity to compare their previous predictions with the actual cultural diversity evidenced in the linguistic landscape. It was used to identify whether students' perspectives on the local cultural diversity in their surroundings had changed, i.e. whether their intercultural competence had been elevated.

5.1 Stage 1: Initial Tutoring, Exploration, and Data Collection

At the beginning of the session the aims of research were explained to students in a 15 minute presentation. Next 15 minute slot was devoted to a discussion about students perspectives on cultural diversity in Lodz as their local environment. The students were asked to think about different languages that are apparent in the city landscape and to prepare lists of most conspicuous foreign languages in the region. All participants who took part in the study had previously studied in Lodz for at least 4 years, and they had general familiarity with the location they were about to explore. For the exploration activities the students were divided into 10 pairs. Each team was requested to explore a different part of city centre. The different quadrants for individual teams were assigned as areas specified by address numbers on the left and right side of the main street. The participants were encouraged to continue their exploration until at least 10 public inscriptions in foreign languages in different spots were discovered. They were given 60 minutes for exploration.

5.2 Stage 2: Discussion and New Perspectives

When the exploration time had ended the teams returned to the institute. The pictures taken with mobile phones in the exploration were collected and mapped by the instructor in Google Maps. The data collection and mapping of the linguistic landscape took 45 minutes. A tangible outcome of the experiment was a shared map that included linguistic sign locations accompanied by pictures and short explanatory notes about each sign, which reflected the linguistic landscape. In the final 45 minutes of the session, the students had an

opportunity to compare their earlier predictions with the linguistic landscape that emerged form the data obtained empirically.

6. OBSERVATIONS

The first noteworthy observation that emerges from the experiment is that there are some evident discrepancies between what students predict and the results of empirical findings. The following 11 languages were included in students' initial predictions: English (20), Italian (15), German (13), French (13), Chinese (8), Turkish (7), Spanish (7), Japanese (2), Czech (1), Russian (1), Vietnamese (1). The linguistic landscape revealed that actually 9 languages were present in the region, including: English (45), French (12), German (7), Turkish (4), Chinese (3), Japanese (2), Italian (2), Greek (1), Dutch (1).

The above listing shows that although all participants rightly predicted that English should be omnipresent in the linguistic landscape of the city, some other languages observed in the area differed from students' predictions as to their occurrence and prevalence. For example, top positions in students' predictions were occupied by other popular European languages, i.e., Italian, German, and French. The linguistic landscape revealed that although the presence of German and French was manifested in the location, Italian was not as strongly visible as it had been expected. Moreover, the expected visibility of Spanish was not confirmed in the exploration at all. Furthermore, no signs of Czech, Russian, and Vietnamese were spotted, but traces of Greek and Dutch were found instead.

The above differences indicate that our perception of the local cultural diversity is significantly biased by personal cognitive representation. The outcomes indicate that what we identify as important in the local environment is what we recognize. English was obviously important and recognizable in the surroundings for English Philology students. Moreover, it seems that French and German occupy prominent positions in the mindsets of students who took part in the study, since they were both included in numerous predictions and spotted in numerous language signs. This indicates that our personal attitudes exert a significant influence on the sensitivity of perception. However, the objective reality of local surroundings sometimes does not meet our cognitive expectations. This is exemplified by the lower than expected visibility of Italian, and the absence of Spanish language manifestations in the location. A further indication that we perceive local cultural diversity from the point of view of our personal cognitive representation is conspicuous absence (both in predictions and submitted pictures) of less popular European languages, e.g. Norwegian, Portuguese, Romanian, etc. They were neither included in predictions nor spotted in the exploration. However, it does not mean that they are not present in the centre of Lodz, but rather indicates that they are not widely recognized, and for that reason they escape our perception.

This leads to the conclusion that cultures that are not fully recognized in cognition become, to some extent, neglected in perspectives on cultural diversity, even if they actually occupy prominent positions in the linguistic landscape. For the same reason, cultures *subjectively recognized as important* not only tend to occupy higher positions in cognitive representations of cultural diversity, but are more easily discernable for us in the surrounding linguistic reality. This conclusion goes along the lines of Piaget's theory of schemata (Inhelder nad Piaget 1958), Papert's theory of constructionism (Harel and Papert 1991), constructivistic assertions that learning is based both upon experience of external objects and former knowledge (Jonassen 1991). It is also congruent with recent developments of cognitive science on the level of mental construal of distant and near phenomena (Trope and Liberman, 2010).

Certainly, the above observations are too limited (short time, low number of participants, small area of exploration) to indicate any general cognitive schemas that pertain to cultural diversity perception or any quantitative/qualitative evaluation of the cultural diversity in Lodz. The activities merely evidenced that there exists an observable discrepancy between the subjective predictions and the objective reality revealed through hands-on empirical examination. This fulfils the aim of activities, which were intended to demonstrate that awareness of local cultural diversity depends on personal perspectives and stereotypes.

When the above observations were summarized in the final discussion, the participants admitted that their awareness of the local cultural diversity had changed. Such broadening of cultural diversity awareness is a sound staring point for further intercultural competence development. As pointed out by Deardorff (2006, p. 255) attitudes of openness, respect, curiosity and discovery for acquiring and processing knowledge about

other cultures are fundamental to the development of the much desired *internal outcomes* of intercultural competence.

7. CONCLUSIONS

A combination of linguistic landscape methodology with mobile learning provides empirical evidence on the variety of languages that are becoming locally relevant in the increasing cultural diversity of the globalizing world. What is particularly valid in the application of mobile learning to the investigation of local cultural diversity is the resulting contextualization of learning (Biggs 2003). Such an in-the-field exploration of the linguistic landscape as discussed in this paper provides authentic environmental cues for better understanding of the cultural diversity phenomenon. As demonstrated in this research the contextualization of learning is achievable to a much greater extend with mobile learning than would ever be possible with the traditional teaching or desk-bound e-learning. The research also demonstrates that mobile learning creates new forms of acquiring knowledge through tasks built around data capture, location-awareness, and connected learning, which brings numerous tangible benefits usually attributed (JISC 2011) to m-learning:

- Integration of abstract (representational) and concrete (environmentally-situated) knowledge;
- Contextualization of learning through location-aware features;
- Reflection in close proximity to the learning event;
- Supporting the learning processes with authentic, situated data;
- Active learning.

This study provides a ready made scenario of authentic, informal, situated m-learning activities in the framework of connectionism which can be employed for intercultural competence development. It demonstrates that it is not technology itself, but how we use it that is crucial for successful implementation of mobile learning in real-life educational settings (Traxler 2009). The use of mobile devices in the linguistic landscape approach adds another dimension to learning activities and expands their potential for applications in foreign language (and culture) teaching and learning practice. The study demonstrates how relatively unproblematic it is to employ mobile learning for an effective and entertaining learning experience. The next logical step in the research is to attest similar scenarios with other types of learning data, e.g. sound recordings, video streams, in other contexts and environments.

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TEXT MESSAGING FOR OUT-OF-CLASS COMMUNICATION: IMPACT ON AFFECTIVE LEARNING

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ABSTRACT

Learning in the affective domain includes the manner by which people deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations and attitudes. While out-of-class communication between instructors and students can impact all types of student learning it has its greatest impact on student affective learning. One of the primary reasons for this is that the out-of-class communication enhances student perception of instructor immediacy. Immediacy is defined as behaviour which increases psychological closeness between communicators. Research studies in instructional communication suggest that enhanced instructor immediacy is linked to more positive student-instructor relationships engendering positive attitudes, increased interest and motivation by students as well as improved attendance, retention, engagement and learning. A year-long research study was conducted into the use of text messaging for out-of-class communication and its effects on student perception of instructor immediacy. Both quantitative measures of immediacy and qualitative feedback from students show that the instructor is perceived as closer, more approachable and responsive when text messaging services are offered. The student feedback also reveals that the use of text messaging has other positive effects on student affective learning, including enhanced motivation and engagement.

KEYWORDS

Text, message, immediacy, affective, learning

1. INTRODUCTION

Effective communication between instructor and student is very important in the quality of the learning experience of students in higher education. Hill et al. (2003) used student focus groups to answer the question of what quality education means to students. Four themes emerged from the study, the most important being the quality of the instructor in terms of delivery, feedback to students and relationship with students in the classroom. However, there are many factors that limit communication between instructors and students in higher education including large class sizes, limited contact time and student reluctance to approach instructors.

While educational institutions generally place most emphasis on student cognitive learning it has been shown that affective learning is also crucial especially to the development of independent and life-long learners. Learning in the affective domain includes the manner by which people deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations and attitudes (Bloom 1956). While communication outside of normal class time (known as out-of-class communication) between instructors and students can impact all types of student learning it has its greatest impact on student affective learning (McCroskey 1994). The importance of out-of-class communication to student affective learning should not be underestimated. Research shows that out-of-class communication between instructors and students can help build more positive instructor-student relationships and hence increase the quality of student learning (Noels et al 1999; Vaughn and Baker 2004).

One of the primary reasons for this is that the out-of-class communication enhances student perception of instructor immediacy (Jaasma 1999). Immediacy is defined as behaviour which increases psychological closeness between communicators (Mehrabian 1969, 1971). Research studies in instructional communication suggest that enhanced instructor immediacy has a positive effect on affective learning and is linked to more positive student-instructor relationships engendering positive attitudes, increased interest and motivation by

students as well as improved attendance, retention, engagement and learning (Christensen and Menzel 1998; Ellis 2004).

This research paper investigates the effect of using text messaging for out-of-class communication between instructor and student on student affective learning. Our findings indicate that the text messaging has a positive effect on student affective learning as well as student learning experience in general.

2. TEXT MESSAGING IN EDUCATION

Text messaging has been exploited for supporting learning in a variety of educational settings. Studies of third-level students have shown that text messaging is used more regularly by students than email and is often students' preferred way for receiving information from their institution (Harley 2007). However, because a text message is limited to only 160 characters it is more suitable for certain types of learning activities than others. A review of the current research literature shows that the ways in which text messaging has been employed in education fall generally into four categories. The first category is when text messaging is used to support and enhance classroom interactivity and dialogue (Clarke and Doody 2008; Markett et al. 2006). The second category is when text messaging is used for administrative purposes such as notifications of changes in the timetable and reminders of assessment submission dates (Naismith 2007; So 2009; Stone 2004). The third category is when text messaging is used as a means of supporting micro-teaching activities including the sending of short summaries for revision, the sending of links to a relevant page on a Virtual Learning Environment (VLE) and also the provision of quizzes and feedback to students (Stone 2004; Tretiakov and Kinshuk 2005).

The final category is when text messaging is used not for learning purposes directly but rather to guide, motivate and support students, encourage participation and engagement, and promote collaboration and co-operation. This fourth category includes many examples where it is used to enhance student affective learning, develop a sense of community amongst students and positively affect student retention rates (Trifonova 2007; Harley 2007). The fourth category may include messages from some of the other categories but the key difference is that the primary goal of the text messaging is to support students and enhance affective learning. As this research paper is concerned with the effect of text messaging on student affective learning it is this final category that is of primary interest.

There are many examples in the research literature where text messaging is not used specifically for the purpose of directly improving academic learning or for administrative purposes but is rather used to support and help students when they are outside class. Such out-of-class (OOC) text messaging may have the aim of enhancing affective learning and improving the learning environment, improving communications, supporting students' transition to third-level education, developing a sense of community among students or positively affecting student retention rates. The potential of the mobile phone as a communications medium in education prompted a research study by Brighton University to explore the use of mobile communication as a way of encouraging a supportive dialogue between students and relevant academic staff. The main motives behind the research were to support students' transition to third-level education and improve retention (Harley 2007). Another very interesting and relevant research study by Griffith University in Australia relates the experience of a female instructor using out-of-class text messaging as a means of staying in touch with her students. The study demonstrates how it can be used as a means of providing connection and a sense of community for first year students and also how it encourages them to persist with their studies (Horstmanshof 2004). Text messaging has also been used by the University of Ulster in Northern Ireland for supporting first-year chemistry students and for the reduction of student drop-outs. The university sends out messages to students of the type 'Sorry, we missed you today'. The students do not find the messages obtrusive in any way, and actually welcomed them (Keegan 2006).

3. METHODOLOGY

An empirical study was designed to investigate the impact of out-of-class communication between instructors and students using text messaging on student learning experience. The study was based in a real educational setting. It was hoped that analysis of the results of the study would provide evidence of an effect of the text

messaging on student affective learning. In total 44 participants from 4 different classes took part in the study. The participants were all third-level undergraduate computing students who were taking between five and six modules each semester. The research study itself took two academic semesters to complete.

3.1 Text Messaging Service

The 44 students who volunteered to participate in the study had the opportunity to use a text messaging service for out-of-class communication with one of their instructors. The instructor used a freeware application called MyPhoneExplorer that was installed on the instructor's laptop together with a mobile phone that was connected to a USB port on the laptop. The software application on the laptop was very versatile and easy to use. In terms of text messaging it operated much like an email program allowing the creation, viewing, editing and deletion of text messages as well as the sending and received text messages via the connected mobile phone. The application could be synchronised with the mobile phone allowing access from the laptop to both the SIM and phone memory. During synchronisation contact details of participants and text messages sent and received could be copied automatically from the phone to the application and visa-versa. The application allowed the sending of text messages to individuals or groups and it also supported the archiving of text messages on the laptop.

3.2 Categories of Text Messages

While it was difficult to categorise some of the messages they generally fell into one or more of three main categories. The first category was for messages that were sent for administrative purposes. The vast majority of these messages were sent as broadcasts to all participants in a treatment group. Only very rarely was there a need to send a message of this type to an individual participant or subgroup of participants. Examples of the use of this type of message include class announcements and cancellations, and reminders of class tests and assignment submission dates. A few examples of text messages of this category that were sent to participants were as follows:

"Hi, I have put the final marks for your continuous assessment up on Moodle. Paul"

"Don't forget you have a test on databases this Friday!"

"Just to remind you that John from BT Ireland is coming in to give us a talk next Tuesday. Paul"

"Hi, DCN class is postponed tomorrow, I have to attend an important meeting, will make it up to you. Paul"

The second category was for text messages that were specifically related to the topics covered in a module that were being delivered by the instructor and the contents of these messages were supplementary to the course material. These messages were sent as broadcasts to all participants and were used for the purpose of micro-learning activities. The messages included short summaries for revision purposes, short or multiple-choice questions and advice on how to prepare for forthcoming classes. Each message was restricted to 160 characters so the messages had to be short and precise. In the case of a text message containing a short question or a multiple-choice question the correct answer was sent as a broadcast text messages to all participants after a suitable period of time. A few examples of text messages in this category that were sent to participants were as follows:

"What is the name of each layer of the OSI network model?"

"What does the letter 'S' stand for in the acronym ISDN? Answer (a) Signals (b) Services (c) Switching or (d) Segment?"

"Do you have any questions on what we covered today in class?"

"The lecture next week is on the topic of DSL. Please look over the lecture notes on this topic prior to coming to class. Thanks"

The third category of message were those whose main purpose was to promote affective learning and included messages that were designed to motivate students in their studies, enhance interest in the subject and to encourage attendance, engagement and participation in class. While messages from the other two categories could have an indirect effect on affective learning this type of message was specifically aimed at enhancing it and included messages expressing pleasure at the effort students were putting into their studies and thanking students for their participation in class. These messages were always sent as a broadcast to all

participants and care was exercised to make sure they were always positive in tone and never critical. A few examples of text messages in this category that were sent to participants were as follows:

"Thanks for all your work and study this week. Glad to hear the projects are getting off to a good start. Have a good one & c u nxt week, Paul"

"You learn something every day if you pay attention ~~ Ray LeBlond"

"Very enjoyable class today. I will try to sort out the issue with the timetable tomorrow. Paul"

3.3 Data Collection

For the purposes of this investigation students who used the out-of-class text messaging service were asked to complete a questionnaire. The questions were formulated based on a review of the research literature on the use of text messaging to support students together with a review the findings of the preliminary studies and the use of the text messaging service to provide out-of-class support to students during the main study. The first section of the questionnaire consists of 30 specific questions about student perception of the use and impact of the text messaging service. Participants were asked to indicate their response to each question on a 7-point Likert scale. The second section of the questionnaire uses a series of open questions to give participants the opportunity of anonymously expressing their personal opinions in terms of communicating with their instructor using text messaging and its impact, if any, on them or their class in terms of learning and education, and the relationship with their instructor. It was hoped that analysis of the student responses to the questionnaire would provide data on the effect of the text messaging on student affective learning.

4. RESULTS AND DISCUSSION

Both quantitative and qualitative data is presented in this section from the responses of participants to the questionnaire. The data is analysed to reveal any evidence of the impact of the text messaging on affective learning. The responses by students to the open questions are especially revealing as they contain many references to the effect of the text messaging on their affective learning.

4.1 Levels of Participation

Participation in the study was purely voluntary and overall the rate of participation was 88%. The total number of messages sent by the instructor during two 13-week semesters of the study was 202. The number of broadcast messages sent to groups of participants was 89 while 113 messages were sent to individual participants usually in response to individual queries.

A total of 155 messages were received by the instructor from participants indicating that participants not only received text messages but actively participated in the communication. Between broadcast messages and individual messages the total number of individual messages received by all participants during the study was 1,005. This means that on average 23 messages were sent to each of the participants and it equates to an average of less than two messages per participant per week.

Even though 202 texts were sent by the instructor during the main study the cost of sending the messages was not prohibitive. The instructor was able to send a lot of the broadcast text messages for free using a text messaging service provided via the website of the mobile provider. In addition the instructor had free text messaging to any students who were using the same mobile provider as himself and most of these students could also reply to him if they wished at no cost. The estimated average cost of the service to the instructor was less than two euro per week.

4.2 Quantitative Results

The first section of the questionnaire consisted of 30 specific questions on the use and impact of the text messaging service. Participants were asked to indicate their response to each question on a 7-point Likert scale. The 30 questions are presented in Table 1 below along with the mean score and the standard deviation

for each question. In addition, for each question the percentage of responses that were scored with 5 points or more is also shown. As score of 5 points or more on any item by a respondent is taken to indicate agreement. Analysis of the results shows that participants generally felt very positive about the introduction and use of the text messaging service with 91% of participants agreeing that they thought that being in touch by text messaging with your instructor was a good idea and 86% of participants agreed that they liked receiving text messages from their instructor.

Table 1. Responses by participants to Section A of questionnaire using 7-point Likert scale (1=definitely not, 7=very much so), n=44

No.	Question	Mean	%≥5	Std.
1	Do you think that being in touch by text messaging with your lecturer is a good idea?	6.11	91%	1.10
2	Do you like receiving text messages from your lecturer?	5.55	86%	1.30
3	Would you like to receive more text messages from your lecturer?	4.43	55%	1.74
4	Were you surprised when the lecturer offered you a text messaging service?	5.57	77%	1.66
5	Do you enjoy the text messaging service?	5.52	77%	1.48
6	Do you like receiving text messages about the module?	6.02	84%	1.28
7	Do you like receiving non-academic text messages from your lecturer?	4.43	55%	1.77
8	Do you think the contents of the text messages you receive from your lecturer are appropriate?	5.70	77%	1.53
9	Do you think the text messaging service has improved your attitude to your lecturer?	5.57	80%	1.45
10	Do you think the lecturer is more approachable as a result of the text messaging service?	5.64	80%	1.60
11	Do you think you are more likely to ask questions in class as a result of the text messaging service?	4.59	61%	1.87
12	Do you think you are more likely to informally chat with the lecturer as a result of the text messaging service?	5.20	70%	1.65
13	Do you think the text messaging service has improved your attitude to the subject?	4.84	64%	1.67
14	Do you think the text messaging service has improved your attitude to the college?	4.57	57%	1.87
15	Do you think the text messaging service has been beneficial to your relationship with the lecturer?	5.25	75%	1.51
16	Do you think the text messaging service has improved the lecturer's attitude towards you?	4.57	57%	1.42
17	Do you think the text messaging service has improved the lecturer's attitude towards the class?	5.25	70%	1.43
18	Do you think the text messaging service has been beneficial to you?	5.75	89%	1.44
19	Do you think the text messaging service has been beneficial to your class?	5.55	80%	1.28
20	Do you like the subject more as a result of the text messaging service?	4.27	52%	1.53
21	Do you think the text messaging service has increased your motivation?	4.31	52%	1.51
22	Do you think the text messaging service has increased your engagement with the subject?	4.34	50%	1.64
23	Do you think the text messaging service has increased your participation in class?	4.55	52%	1.62
24	Do you think the fact that the text messages can be sent and received at any time and in any place is an advantage?	5.77	84%	1.61
25	Do you think that text messaging is an effective approach to support learning?	5.93	86%	1.19
26	Do you think you respond better to the text messages than you would to emails?	5.36	73%	1.90
27	Do you think text messaging is useful for the organisational side of learning such as announcements about room changes etc.?	6.48	93%	0.90
28	Do you think the text messaging service has helped you in your learning?	5.00	73%	1.48
29	Are you concerned about the potential cost of replying to the text messages?	3.34	34%	2.27
30	Do you feel that receiving text messages from your lecturer is intrusive?	2.80	16%	1.80

In terms of the effect of the text messaging on their relationship with their instructor three-quarters of participants agreed that the text messaging service had been beneficial to their relationship with the instructor and over 80% of participants agreed that it had both improved their attitude to their instructor and made their instructor more approachable. Just over half of participants agreed that the service had improved their attitude to the college, had increased their liking for the subject and had increased their motivation, engagement and participation.

When asked if they were concerned about the potential cost of replying to the text messages 34% agreed that they were. However only a small number of messages sent had needed a reply and more and more students are now availing of free text messaging. While 84% of participants did not agree that receiving text messages from your instructor was intrusive a small number of participants had responded to question 30 with a score of 5 or more. This was taken seriously and further emphasised the need for careful and judicious use of the service and the need to speak to participants about any concerns they might have and also the need to make sure they fully realised that they could withdraw from the service at any time of their choosing. When asked what they thought about the use of text messaging to support learning 86% of participants agreed it was an effective approach.

In summary the participants generally liked receiving the messages and they perceived that it improved their relationship with their instructor and his attitude towards them. It also made the instructor more approachable and made it more likely for them to talk to the instructor informally. Many participants agreed that the service had improved their attitude to the college, had increased their liking for the subject and had increased their motivation, engagement and participation. This was taken as evidence of an effect on student affective learning of the out-of-class text messaging.

4.3 Qualitative Results

The second section of the questionnaire gathered qualitative data from participants on their perceptions of communicating with their instructor using text messaging and its impact, if any, on them or their class in terms of learning and also in terms of the relationship with their instructor. A series of open questions were used to give participants the opportunity of anonymously expressing their opinions. The responses from the participants to the open question provided a great deal of valuable and insightful feedback into their perceptions of the effect of the text messaging service on their learning experience. Analysis of the responses provides further evidence of the effect of the text messaging on student affective learning.

The overwhelming majority of the feedback was very positive. The participants generally perceived that the text messaging had made them feel closer to the instructor and they felt more comfortable asking questions in class, or outside of class, about the course. One participant, who was a mature student, responded it “has motivated me more to come to class, has improved my attitude towards college and subjects”. When asked in what ways (if any) they thought the text messaging service has been beneficial or detrimental to your class in general they again mostly responded very positively. They felt it improved communications and had improved the class’ relationship with the instructor and as a result they felt they had a more comfortable atmosphere in class and they perceived that their learning was better. They also felt it had brought the instructor closer to the class, had become a talking point among them, and had brought the class closer together as a result. They also perceived that there were many benefits from it and that the class had a higher attendance as a result. When asked in what ways, if any, they thought the text messaging service has helped or hindered them in their learning some of the participants responded that it reminded them to study before class and was better than email for notifying them at short notice of any changes to the schedule.

The responses to the last question are particularly revealing in terms of the overall assessment by participants of the use of text messaging for out-of-class communication and their perceptions of the study. The participants generally responded that it was a good service to students and improved communications. They also felt that others should use text messaging as a means of communication and that it was easier to communicate by text than by email. One participant felt that it should be applied to all modules. They also felt the research study was innovative and should be developed further as it was a different approach in dealing with instructor-student communication.

5. CONCLUSIONS

Analysis of the quantitative and qualitative data provides evidence of a positive effect on student affective learning of the use of text messaging for instructor-student out-of-class communication. While a few participants did express some concerns about the text messaging, it was generally felt that the text messaging had made the instructor more approachable and as a result it was easier to talk with them, giving the participants a feeling that the instructor cared about them. A number of participants mentioned that the text messaging made them more likely to attend class and made them feel more comfortable in class. In addition, some reported that it also encouraged and motivated them in their learning. This is further evidence of the text messaging having a positive effect on student affective learning as well as student learning experience in general. As this study was conducted in just one educational institution further research studies will be needed to explore the scalability and generalisability of the results across multiple educational institutions, subject domains and cultures.

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PRISMA-MAR: AN ARCHITECTURE MODEL FOR DATA VISUALIZATION IN AUGMENTED REALITY MOBILE DEVICES

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ABSTRACT

This paper proposes an extension to mobile augmented reality (MAR) environments – the addition of data charts to the more usual text, image and video components. To this purpose, we have designed a client-server architecture including the main necessary modules and services to provide an Information Visualization MAR experience. The server side includes face recognition using OpenCV, and a visualization engine, using the PRISMA tool. The client side is focused on presentation and interaction, with a prototype developed for the iOS6 operational system and compatible with iPhone and iPad devices. The prototype is a MAR app that uses face recognition to identify the user and graphically presents related academic information.

KEYWORDS

Information Visualization, Augmented Reality, Mobile, Facial Recognition.

1. INTRODUCTION

The recent technology improvement in mobile devices, as tablets and smart phones, and wireless communication allowed the users to use services as email access, web navigation, social networks and others, that before was limited to the desktop platform, in almost everywhere.

With these improvements, the users demands more and better applications supporting services in mobile devices. It is not limited to the services available in the desktop, but also services that use features of the mobile devices as the Global Positioning System (GPS) for, as an example, acquire information about a facing restaurant, its menu, nutritional information about the food and drinks, etc.

The Augmented Reality (AR) for mobile devices, in association with geolocalization or image recognition, allows new ways to relate information and interaction with the real world. Basically, AR overlays information layers over real images, live or not, catch by the mobile device camera. The commonly ways to present information using Mobile Augmented Reality (MAR) applications are using text, images and video, being the first two, or a combination, of them the most used for the grater majority of the applications.

In this work, we propose the use of Information Visualization (IV) charts into Mobile Augmented Reality environments, as a way to present information enriching the real world vision. The use of IV charts can be used alone or associated to other medias, such as text, images and videos.

This paper presents an architecture designed to aggregate the components and services needed to properly join IV in a MAR environment, detailing its main modules and how it fits together. We also describe a prototype implemented to validate the proposed architecture and a use case of this prototype, offering support to the interaction between teacher and student in a classroom context. The prototype allows the teacher to use the mobile to point the camera to a students' face, recognize it and get academic information about the student (like grades, absences, etc.) and its comparison against the class mediums in a graphical form.

For the prototype development, we choose a client server approach, using iOS 6 in the client side, the PRISMA (Almeida& at el., 2009) information visualization tool and the OpenCV recognition mechanism (OpenCV, 2012) in the server side and access to distributed data sources, locally or on the cloud.

The rest of this paper are organized as follow: Section 2 and Section 3 presents, respectively, some concepts about mobile augmented reality and information visualization; Section 4 list some of the previous works that served as base for this work; Section 5 shows the developed prototype, detailing its architecture and main functionalities; finally, Section 6 make some considerations about this work and lists future works.

2. MOBILE AUGMENTED REALITY

With the appearing of tablets and smartphones, it became possible to run in mobile devices applications that were restricted to the desktop environment, once they have the required resources to run more complex and multimedia applications, resources as more powerful CPUs, more memory, multimedia resources and a considerably amount of sensors (as compass, accelerometer and cameras). So, the concept of Mobile Augmented Reality found a favorable environment, in the current tablets and smartphones, for its diffusion.

The Mobile Augmented Reality generates virtual images mixed to the real scene outputted in the user's video screen. Beyond the characteristics pointed before, the mobile devices had the advantage of being easily carry able, connectable and wireless devices. For those devices the concept of See-Through Video is the most commonly used. The device's integrated cameras catches the environment images in real time and the augmented objects are superimposed to the camera image, creating the augmented reality image that is showed to the user (Figure 1).

Figure 1. AR application with tourist ends, running on iPhone; (a) German Parlament (augmented image overlay) (b) The Sidney Opera (augmented information). (Endigy, 2011)

3. INFORMATION VISUALIZATION

The Information Visualization research area studies the transformation of abstract data into images easily visualized and understood by the human beings (Spence, 2001). Information Visualization tools are computer-based tools that support interaction and data presentation mechanisms. The tools should allow the user to easily and efficiently manipulate and visually rearrange multidimensional data in order to support data analysis. The goal of information visualization tools is to improve data perception, correlation and exploration (Ward & et al., 2010).

The characteristics of a good information visualization tool are defined according to the following user tasks (Carr, 1999).

- Overview of the entire dataset.
- Zoom: focus on a certain data subset.
- Filter: reduction of the dataset according to specified attribute values.
- Details on Demand: additional data provided by an action performed by the user.

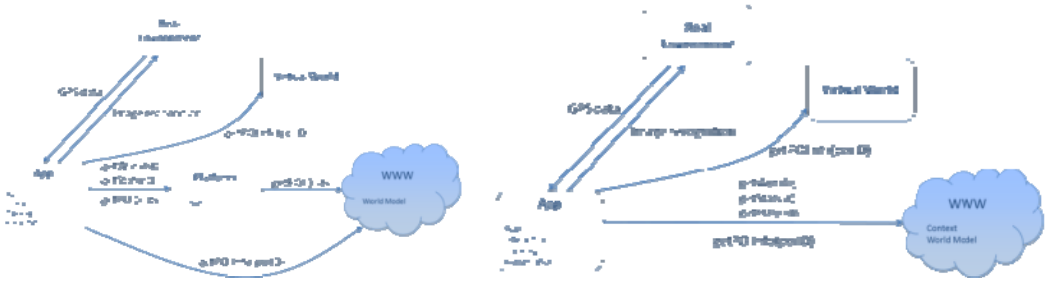
In this work, we decide to use the Bar Chart and the Star Chart techniques. The bar chart is a XY chart that shows the relation between amount and value of a given attribute using bars. One axis represents the amount scale for the different attribute values in a given dataset, while the other represents the assumable categorical values for the attribute. Figure 4 shows bar chart.

The star chart is a multi-dimensional technique that represents each attribute in a radius, starting from a common initial point. These attribute axes are uniformly angled and do not necessarily are in the same scale,

as long as a proportion among the scales are kept. Once the axes structure are prepared, for each item in the given dataset are plotted line segments connecting the points related to that item value in an axis pair.

4. RELATED WORK

Butchart (2011) presents a brief comparison among architecture styles for mobile augmented reality using AR browser. Butchart uses a reference model (Reicher, et al; 2003) to classify kinds of architectures: Gateway, Web and Standalone. The Gateway architecture is the approach used for most of AR browsers, being characterized for the need of a web server that attends to the browser requests for content and other information. The Web architecture eliminates de server as centralizer of the requests, making the AR browser access directly the WWW and its services. In the Standalone architecture the application is not dependent of an internet connection having full control of the application data and not needing to handle with data updates, but requiring a full installation of a new version when a data update are required. The Gateway and Web architectures are show in Figure 2.



(a) (b)

Figure 2. Mobile AR architectures (a) Gateway e (b) Web (Butchart, 2011)

(Dantone, at el., 2011) presented an automatic system for face augmentation on mobile devices (Figure 3). A user can point his mobile phone to a person and the system recognizes his or her face. A tracking algorithm overlays information about the identified person on the screen, thereby achieving an augmented reality effect. The tracker is running on the mobile client, while the recognition is running on a server.

Figure 3. Automatic Face Recognitition on Mobile Devices. (Dantone, at el., 2011)

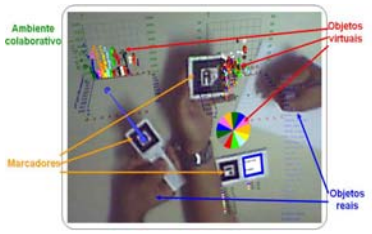


Figure 4. Augmented Reality Visualization Information. (do Carmo, at el., 2007)

Figure 5. Examples of mARGraphy: Dish viewer. Choi, at el., 2011)

(do Carmo, at el., 2007) presented a prototype that implements multiple coordinated views to information visualization in augmented reality environments (Figure 4). A modified version of ARToolKit has been used to create the augmented environment, and the 3D scatter plot technique has been developed to represent the multiple views of data. The coordination between views supported dynamic queries, data selection, and the configuration of views and of the detail on demand feature.

(Choi, at el., 2011) proposed a tool named mARGraphy (Figure 5), which visualizes information based on augmented reality (AR) technology to understand dynamic 3D information. They have used a traditional map viewer application as study case. It recognizes region of a traditional map with object recognition and tracking method on a mobile platform. Then, it aggregates dynamic information obtained from database such as geographical features with temporal changes, and situational contexts.

PRISMA information visualization tool that explores the use of multiple coordinated views (Godinho, et al, 2007) (Figure 6), and it has been developed in Java language. The PRISMA Web version has used standard web development technologies and patterns like Ajax and Java were applied (Almeida & et al, 2009) (Figure 7). The technologies used for the client application include simple HTML pages with CSS and Javascript for manipulation and automatic generation of the interface. AJAX (Asynchronous Javascript and XML) and JSON (Javascript Object Notation) were used for client-server communication. The server generates a view in response to a user request, converts the view into an image and transfers the generated image to the client.

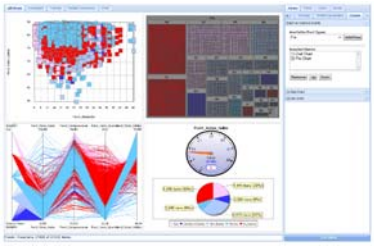


Figure 6. Prisma Web Client. (Almeida & et al, 2009)

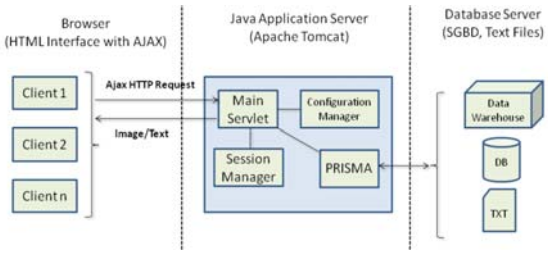


Figure 7. Prisma Web Architecture. (Almeida & et al, 2009)

5. PRISMA - MOBILE AUGMENTED REALITY (PRISMA-MAR)

This section describes the implemented prototype, along with its main functionalities and internal data flow. The architecture defined for the prototype, and the components that compose it, are also presented.

5.1 Architecture

The prototype architecture is client-server based, where the prototype uses the PRISMA Server to handle both the dataset and visualizations processing. The mobile device is mostly responsible for the inputs and outputs of the application. There are two way to input, by the camera and by the display.

Figure 8, shows a macro vision of the prototype functionality, showing an overview of the interaction and communications of each physical agent in the process.

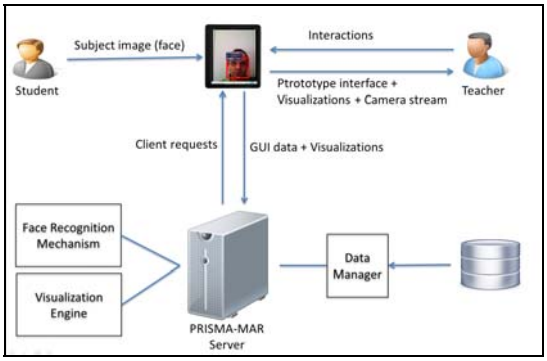


Figure 8. PRISMA-MAR Architecture Overview

The mobile device inputs the video stream (the face to be recognized) and after loading subject data, it controls the interaction from the user. If this interaction causes in the visualization or in the dataset changes (e.g. filters) the prototype sends to the PRISMA Server the new defined configuration and gets the metadata to update the user interface and the new generated visualization.

With the app started, the user point the camera device to the face to recognize, the recognize gets the identifiers of that face and uses to request the data about that subject. Once loaded, the prototype starts the visualization interface, both chart and controls, allowing the user to interact with the visualizations and look for the information needed.

5.1.1 Internal Data Flow

The first user interaction is the login. It not only avoids unauthorized access to students' information, it also reduces the amount of data used in the face recognition process, limiting the search for a face match to the students of a given class.

The Client Core (Figure 9) is responsible for the communication among the client modules and the control of the application execution. The Client Core uses the Facial Tracker to detect a face in the input stream from the camera to detect the presence of a face. Once a face is detected, the Client Core calls the GUI Manager to ask the user if the detected face is to be recognized.

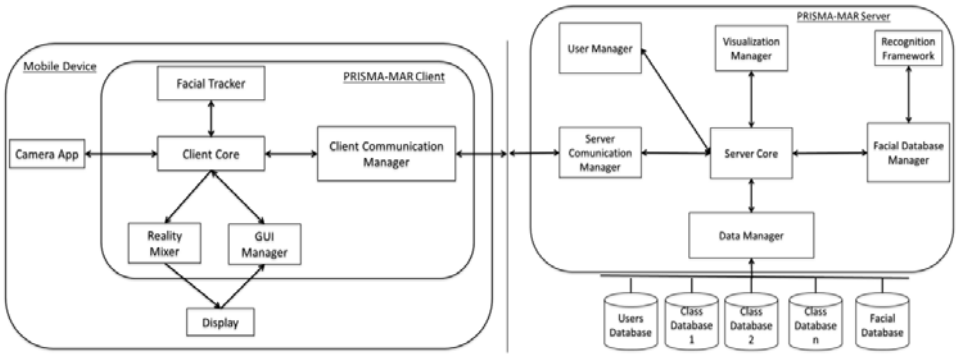


Figure 9. Application flow

The Facial Tracker is a third-part component attached to the prototype architecture as a plug-in. We chose the CIDetector API (Roche, 2011) as this plug-in, but it can be easily exchanged for another facial detection mechanism. It is used only to detect if a face is being caught by the camera and inform it to the Client Core.

If a face is chosen to be recognized, the Client Core gets a set of frames from the camera and passes those to the Client Communication Manager along with a loading request. The Client Communication Manager performs a web request posting the frames with the subject face.

On the server side (Figure 9), the Server Communication Manager receives the load request plus the camera frames, and informs it to the Server Core. The Server Core sends the camera frames and the selected data sources to the Facial Database Manager that uses it to search for a face match and return to the Server Core a subject ID.

The Recognition Framework is a module loaded into the PRISMA-MAR Server. For this initial state of the project, we chose to use as Recognition Framework an implementation of the OpenCV library (OpenCV, 2012), using the Eigenfaces algorithm (Kshirsagar, 2011). The Recognition Framework is used by, and its communication logic, are enclosed in the Facial Database Manager, allowing it to can be replaced with no major code changes in the MAR Server.

The Server Core passes the subject ID along with the selected database reference to the Data Manager. The Data Manager loads the requested information from the data sources (DBMSs, text files, etc.) and processes it to extract the class average for each attribute in the database. The Data Manager then structures this averages as registry and generates a new temporary reduced dataset, containing only the subject information and the class averages, and returns it to the Server Core. The Data Manager also extracts from the database the metadata for the client interface configuration.

The Server Core starts the Visualization Manager with the reduced dataset and the information needed to generate the visualizations (e.g. the type of visualization to be drawn, preferred size of the image, etc.). The Visualization Manager then applies the visual encodings for the reduced dataset and do the math to generate the visualization. After completely generated, the visualization is encoded into an image file format and sent to the Server Core.

Having the visualization image and the metadata for GUI, the Server Core calls the Server Communication Manager to encode and send the information to the client. After receiving this response, the Client Communication Manager passes the return to the Client Core. The Client Core uses the GUI Manager to dynamically create the user interface and fill its controls and visualizations. Once the user interface are completely instantiated, the Client Core sends its information alongside with the camera stream to the reality mixer, for positioning and rendering on display. Once the user interface is rendered, the GUI Manager also

keeps track of user interactions over the display, dispatching those to the Client Core. If the subject is exchanged or the user interacts in a way that modifies the application data or visualizations, the process starts over again. A detailed vision of this flow is shown in Figure 9.

5.1.2 Server Integration

The PRISMA (Almeida & et al, 2009) is an information visualization tool that offers multiple visualizations, support for multiple data sources and an extensible architecture, allowing the use of selected subsets of functionality. Considering the set of services provided for the PRISMA tool and the possibility to develop new interfaces to support new environments over this framework, we developed the prototype server side as a PRISMA interface. The MAR interface abstracts the complexity of handling the data sources, pré-process the data and the process of building the visualization, delegating it to the previously available modules of the PRISMA.

The data and metadata transferred between client and server is JSON (JSON, 2012) formatted and, due to the data reduction step in the server side, it is a pretty lightweight communication (not considering the images). Both textual and images data are exchanged by post requests and responses. At each side (client and server), the Communication Manager holds the intelligence to encode/decode the communication protocol to and from the internal data structures.

The PRISMA-MAR Server provides a one node link for the client, using a single provider for all the kinds of services it may came to consume. This feature does not limit the client, once any third-part service may still be able to load through the server (e.g. a Database Management System on the cloud), it actually provides a safer entry for third-part data (once the MAR Server pre-process the databases and validates it) and makes the client implementation simpler (considering it does not need logic for connecting with different servers).

To the user, this approach reflects in very lightweight client, once it does not include or keep databases, unnecessary code, subject images and any other thing related. It also means improved performance, since the MAR Server performs the databases operations and math processing sending only the displayable results for the client. In fact, the MAR Client is just a bridge (interface) for the user interactions, filling the GUI with the MAR Server responses.

5.2 Application

In the following sections we present the principals characteristics and functionalities of the client-side application.

5.2.1 Login

Beginning the application, the user is prompted with the login screen, requesting its username, password and class, for retrieving data, (Figure 10). After a successful login, the app show a screen with the command bar (initially disabled) containing: Overview, Details and Filter buttons, and a Face Detection Switch component to activate/deactivate the face recognition process (ON/OFF).

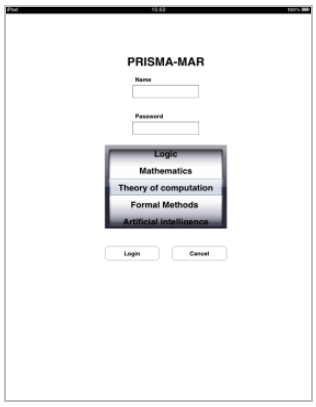


Figure 10. Login Screen.

Figure 11. Face Detection Process.

5.2.2 Face Detection

In order to start the detection process, the user should activate (ON) the Face Detection Switch. After that, when a face is detected in the camera image (Figure 12) the app ask the user if that face should be analyzed for further information. In the application context, the face should belong to a student and the information draw as visualization charts are the points of interest in its academic performance.

Figure 12. Face Detected.

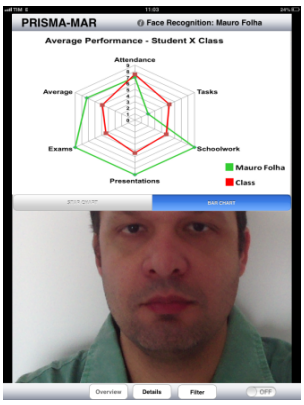


Figure 13. Star Chart Visualization.

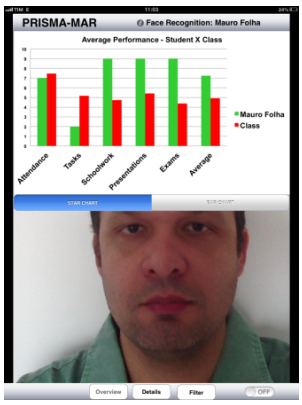


Figure 14. Bar Chart Visualization.

The first graphic loaded to the application is the Star Chart, containing information about the medium of test grades, class attendance, etc. comparing the recognized student's values (green line) with the medium of values of the students' class (red line), as show in Figure 13. The initial visualization is an overview chart about the student's performance and the user can choose between analyze it using the star chart or the bar chart (Figure 14). At this point the Details and Filter buttons are already available for interaction and the Face Detection Switch are disabled.

5.2.3 Details on Demand

In the PRISMA-MAR client, the Details on Demand allow the user to analyze the composition of the subject student media for a chosen dimension. Figure 14 shows a student that got an average grade of 9 in his tests. It does not answer questions as "How many tests did the student took?" and "This student's performance are improving along the semester?". To answer some of these questions, the Details on Demand feature can be accessed by the button Details (Figure 15 and Figure 16), that activate charts about these detailed information, both for the subject student and the class.

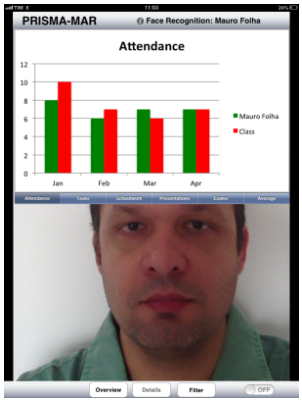


Figure 15. Details on demand – Attendance.

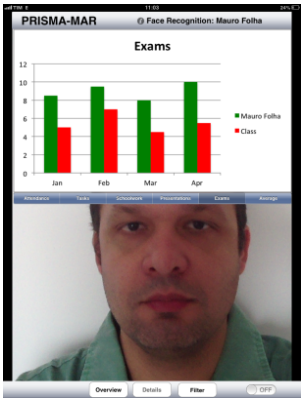


Figure 16. Details on demand – Exams.

The access to each dimension are made by the buttons below the detail chart, the user just press the button labeled with the attribute name to be analyzed and that dimension chart are draw in the visualization space. The user can chose the attributes "Attendance", "Tasks", Schoolwork, etc., as show in Figure 17.

Figure 17. Details Choosing Bar

5.2.4 Filter and Zoom

The Filter feature allows the user to insert or remove attributes in the visualization. When activated, the Filter Button render a menu with all the attributes in the dataset to the user select the ones to be rendered (Figure 17). Leaving the Filter menu causes the visualization to be updated, as can be seen in Figure 18, in comparison with Figure 16, with two attributes removed.

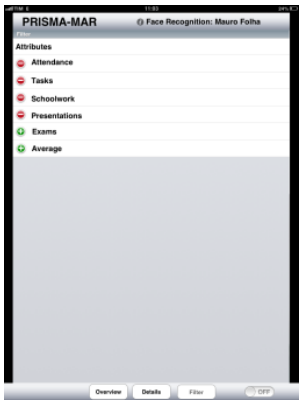


Figure 17. Filter Menu.

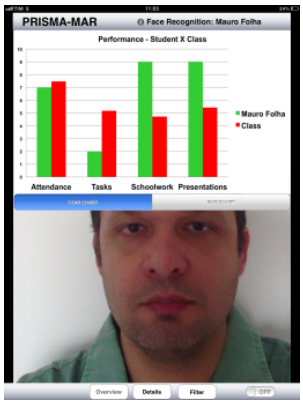


Figure 18. Filtered Visualization.

The Zoom feature was kept as the standard in mobile applications. Sliding two fingers away one to other causes the visualization area to be scaled up, enlarging the visualization.

6. FINAL REMARKS AND FUTURE WORKS

The main contribution on this work is the integration among mobile augmented reality, facial recognition and information visualization. In this paper we presented an application that joining the mentioned concepts, allows teachers to gather academic information about a student and relate it to the average of the student's class.

The main difficulties found during the development of this work were related to found and integrate frameworks of facial detection and recognition. We notice that factors as environmental light, face positioning, occlusion, movement, etc. holds high influence in the recognition process.

We simplified the application defining usual menus as the interaction mechanism, instead of interactions directly over the visualization. The application is also adaptable since the data and visualizations (as images) are sent to the app by the PRISMA-MAR Server. The client application attends to the good characteristics of visualization tool: overview, zoom, filters and details on demand.

The iOS platform was chosen for this first prototype mainly because of the experience of the development group with the platform, but other platforms will be used in future works.

At this point of the development we chose to lock the visualization in the screen once it is loaded to a recognized face, once the face for some reason may be removed of the camera focus. A mechanism similar to a cache memory are currently under development to make the face recognition process more dynamic without overloading client and server with these tasks.

6.1 Future Works

The main future works for this project are listed below:

- Evaluate the user interface and conduct user tests;
- Implement analysis for multiple subjects at time;
- Conduct performance tests in a real environment;
- Improve the level of correct matches in the facial recognition process;
- Design and evaluate a cache mechanism to improve performance in the recognition process;
- Implement new information visualization and coordinated techniques;
- Create new filter mechanisms, for other kinds of data;
- Create an PRISMA-MAR Client for the Android platform.

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WHAT DO CONTEXT AWARE ELECTRONIC ALERTS FROM VIRTUAL LEARNING ENVIRONMENTS TELL US ABOUT USER TIME & LOCATION?

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ABSTRACT

The paper describes the analysis of user location and time stamp information automatically logged when students receive and interact with electronic updates from the University's virtual learning environment. The electronic updates are sent to students' mobile devices using RSS feeds. The mobile reception of such information can be received in three dimensions of context: time, location and activity. Fifteen students took part in this study with the three dimensions of context evenly distributed. The study aims to identify how users can engage with electronic updates related to teaching material, course work feedback, and general announcements from teaching staff across the University's academic departments. As well as user profiling when reading the updates under these three dimensions of context, early investigations show that there exists peak times when users read these updates. All three dimensions exhibited a similar trend with activity being the highest. Initial results indicate that interactions occurred generally during office hours and within the confines of the campus environment, although uses of the activity based application were recorded also in informal locations outside of the working hours.

KEYWORDS

Context Aware, Mobile Information Delivery, Virtual Learning Environments, Ubiquitous Learning.

1. INTRODUCTION

Virtual Learning Environments (VLE's) have existed long before the digital revolution and continue to develop from the original mail based systems to the modern online structures which are now an integral part of course delivery. The majority of higher education universities have adopted VLE's to enhance the face-to face learning experience to instigate a blended learning approach. Higher and further education institutions now understand learning is no longer restricted by the physical boundaries of their retrospective campuses, as learning interactions occur throughout the entire student experience. In addition to the formal and traditional learning spaces, the informal physical and virtual areas may now encompass a wider range of distributed learning areas and possess an importance which requires further understanding. Investigating the ubiquity of spaces in order to enhance the learning and teaching experience is not only important for students but also for faculty who value the potential benefits which are available with the adoption of mobile technologies when delivering information to students. This heightened awareness of learning transpiring within different contexts has given rise to concepts such as 'ubiquitous' or 'flexible learning' as defined by Moran and Myringer; in which mobile devices have been seen to both provide and promote.

The evolution and progression of mobile technologies such as wireless networks and handheld devices provide ubiquitous access for both information delivery and retrieval, as stated by Muhammad and Soraya. At the same time the penetration and popularity of 'smart phones' have provided a platform for users to receive updates for information such as news, shopping and social media in a concise and convenient method. Traxler identified that mobile devices allow for portability, connectivity, convenience, expediency, immediacy, accessibility, individuality as well as Song arguing 'interactivity'. These attributes are the reasoning behind the popularity and penetration of mobile technologies within general society as well as their impact within educational environments.

Although mobile applications are used for a wide range of purposes, their functionality often relies on executing functions or services based upon a frequency of time. Although these are effective in their activity, they have been proven to generate issues with users, as demonstrated by Crane et al. However with the integration of both global positioning systems (GPS) or assisted GPS functionality in most smart phones; location awareness can now be integrated into information systems as update points, mostly referred to as 'Location Based Services'. It is these schedule based services and location based services which are deemed the two fundamental points for context aware applications as stated by Smailagic. It is this integration of location based services into mobile applications which has created a plethora of application fields such as shopping, advertising, travel information and entertainment. Although location based services have been utilized successfully for many domains, their use in the organization and supporting of learning has not been fully exploited. With technology now available to provide a higher level of context adaptability within higher education course delivery, information which students receive has new possibilities in the way in which it is retrieved and delivered. Given the individual characteristics that can define circumstances and subsequently, the ambient information which can be gathered by mobile devices, Yau & Joy argue there may be benefits to the learner if their mobile application were to be aware of these dimensions of context. As well as the requirement for context to be integrated into the VLE; the technology enhanced learning research group'; the STELLAR network has identified 'contextualizing virtual learning environments' as one of its three grand challenges which need to be addressed for the future of technology enhanced learning .

Within recent literature there are numerous studies such as Sohn et al as well as Marmasse and Schmandt, which exemplify how location based services can be integrated to support the organization of a mobile user. This study demonstrated the principle that reminders can be created and executed on specific GPS co-ordinates rather than at a defined time of the day. It is this concept of using other forms of context to deliver information to a user's device while on campus which is of significance. In order to provide a ubiquitous information environment, understanding the context of the user must be of paramount importance for the appropriate information retrieval and delivery. Therefore the inclusion and integration of other dimensions of context are now possible by the technology; it is the understanding the usage and impact on the user within an educational setting which is of importance. Previous work centered on comparing both time and location as methods of delivering information, but further work to evaluate a third dimension of context has provided data on the context in which the users interacts with their device.

This paper is structured in the following format, it firstly defines which aspects or dimensions of context can be utilized for delivering information to student's devices from virtual learning environments. From here, the investigation into mobile virtual learning environments is explored before the implementation is provided in detail.

2. DEFINING & DEDUCING CONTEXT

The understanding and definition of context has been a research field spanning decades, but has its potential realized with the arrival of mobile devices. Since Barwise described situations over three decades ago, the importance of other contextual aspects such as the individual and the relationships to other objects were understood. More recent work by Dey investigated and promoted the concept of context being more multi-faceted than that of location awareness.

Most contemporary context-aware mobile learning applications operate with what are recognized as 'learning contexts' in order to appropriately adapt or organise information to users in a learning environment. Learning contexts has been defined by Baseed et al as "*the circumstances in which, or conditions that surrounds the learning*. It is this classification of context which has created much discussion and research. The most recognized model for context dimension is that of a pentagonal form consisting of time, location, activity, identity and relationships as demonstrated by Zimmerman, Lorenz and Oppermann. Table 1 below provides a definition of each dimension used within this study of context, as suggested by Zimmerman et al.

Table 1. Defining the five contextual dimensions by Zimmerman et al

Dimension of Context	***Definition***
Identity	This category gives access to contextual information about the entity the context is bound to. This information comprises anything that can be observed about an entity, typically its state.
Time	This category of context subsumes time information like the time zone of the client, the current time or any virtual time.
Location	A location may be described as an absolute location, meaning the exact location of something, or as a relative location, meaning the location of something relative to something else.
Activity	The activity dimension of context covers the activities the entity is currently and in future involved within. It described by means of explicit goals, tasks, and actions. In most situations when interacting with a context-aware system, an entity is engaged in a task that determines the goals of the performed activities.
Relationship to n	This dimension of context information captures the relations an entity has established to other entities. Such surrounding entities can be persons, things, devices, services, or information (e.g. text, images).

Although defining context is crucial when understanding context's position in the delivering of course materials to students; it is far too simplistic of a concept. Understanding if one dimension of context outweighs another for a student in a particular context becomes of interest to the research as it is important in deciding the best mechanism for context-aware delivery. The precedence of each of the dimensions needs to be addressed in order to deliver information and course materials appropriately in context. Dey stated that "*We cannot enumerate which aspects of all situations are important, as this will change from situation to situation"*. Evidently, this proved true by Crane et al, although there were slight differences between the responses within the different context-situations; a general theme emerged from the results. Only activity, time and location were deemed important in each context in their current definition. Of course this is was a theoretical evaluation and therefore future conclusions must be formed upon implementing time, location and activity based information retrieval as real and user tested mobile applications.

The sensing and deducing the context of the device in its operating environment requires direct access to the phone's sensors, and therefore using the application programming interfaces (API). Most smartphones have a range of integrated sensors which allow an application to exploit these into forming conditional statements for which information can be delivered upon their execution. Figure 1 demonstrates how each of the five dimensions of technology can be sensed using the sensors within a mobile device. Of course, by utilizing these sensors, user permissions must be accepted during the installation process; if the user doesn't grant these permissions the application will not function as the functionality is dependent upon accessing API data. The Android application installation method means no further checks with the user are done while an application is running: it had to be granted a particular permission when installed, and can use that feature as and when desired.

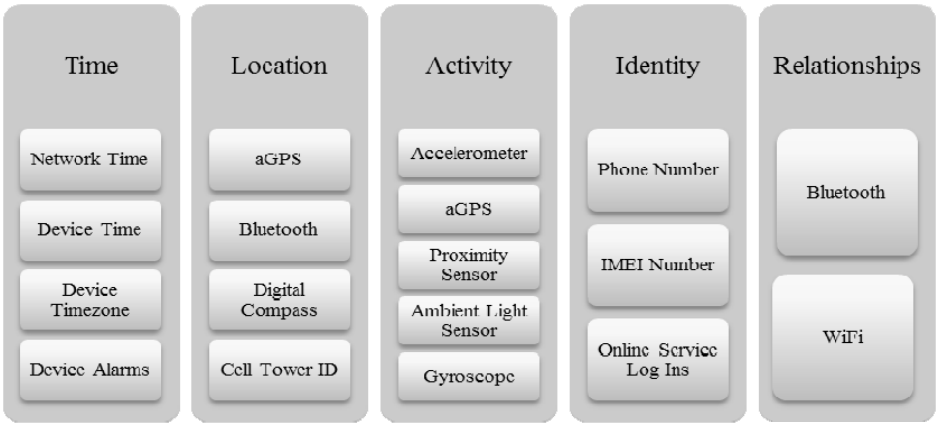

Figure 1. Demonstration of the sensors available in smart phones which could be used to sense or determine user context.

3. DISSEMINATING INFORMATION FOR FLEXIBLE LEARNING

Disseminating information to students from the central VLE is imperative to support the notion of flexible learning to be 'anytime, anywhere'. There are a plethora of technologies which can be used to deliver information to mobile devices; including channels such as SMS or E-mail, RSS has been proven by Lan & Sie**,** to perform superior to both SMS and Email on content accuracy and adaptability; therefore rendering RSS as more appropriate for supporting various front-end mobile devices to access and present the content in a mobile learning environment. It is this RSS channel usage which not of question, but how in which it can be delivered in accordance with the user's context to add to the learners experience.

Mobile technologies afford flexibility to the student experience in higher education and subsequently, they will become increasingly significant as students and academics pass through physical, blended and virtual learning environments. The Horizon Report argues there is a shift in the method that users are connecting to the internet directly caused by *"..the growing number of internet-capable mobile devices, increasingly flexible web content, and continued development of the networks that support connectivity*." It is the importance of the context which is debated by many; as when using mobile technology, the learning occurs within context and this context constantly changes. Yet, others such as Keppell and Riddle argue that context becomes almost irrelevant and of no particular no value as mobile technologies can transform any space into a 'learning space'. It is this importance of the dimension of context which is of question, for example is location actually important when receiving information based upon that context itself.

Again, this same concept applies to the context dimension of time; does time become more fluid and adaptable when mobile devices provide a variable to their respective context. This hypothesis which is stated by Jones and Jo amongst others, believes any setting in which students can become totally immersed in the learning process can be seen as a ubiquitous learning environment. Therefore if context awareness was integrated into mobile alert delivery; would the traditional and physical boundaries of time and location still be valid for learning or alternatively subjected to new patterns of mobile stimulated ubiquity.

4. IMPLEMENTATION

Although like many other VLE's or Learning Management Systems (LMS); Moodle provides RSS channels which are available for such items as announcements and discussions. With careful discussion with the universities Information Systems Services, a method of including other updates such as changes or updates to uploaded files could also be implemented using PHP to create one stream or RSS channel which aggregated more information surrounding a certain course of module.

The software for each of the applications was built in native Android using the Eclipse development environment. All three of the mobile applications used Java for the majority of the functionality, such as notifications, menu creation and the parsing the XML format of the RSS alert feed. In order to ascertain the context of the user, the Alohar API was integrated into the applications. The programmable interface provides battery optimized, ambient sensing & location awareness platform which enable developers to build a whole new class of mobile applications that understand a user's behavior automatically and provide highly customized services to the user at the right time and right place. For this study this included the automatic detection of walking, sleeping and commuting as well as understanding the place type of where the device is, in correlation to Google Places data.

The automatic logging system developed parallel to the application was a combination of Java and AJAX to push data including the latitude, longitude, device id, and timestamp to an online SQL server for further analysis. This function was intentionally concealed from the user when using the applications in order to provide ethnographic data to observe the user's behavior with the technology.

The three separate native Android applications were developed which delivered information based upon either the user's specified time, location on campus or their current activity. The applications were installed randomly on the student's Android devices in order for them to receive notifications when a new item has been posted within a given module on Moodle.

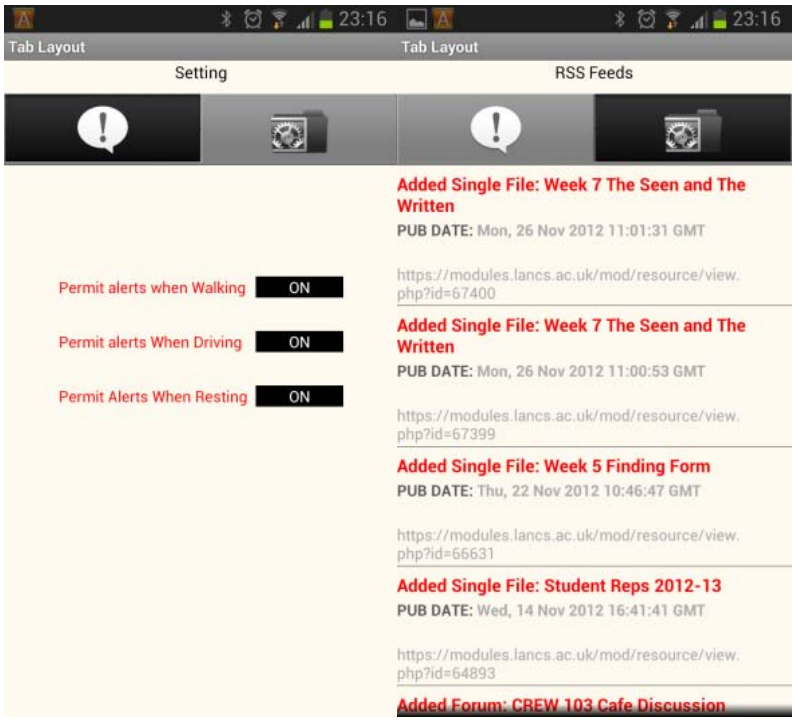

Figure 2. Screenshots of the Activity based RSS Alert Application, showing both the settings page and course alert list parsed from the XML channel.

The applications were installed upon 15 students own handsets, from a range of six different modules which included Environmental Sciences, English, History and Computer Science disciplines. Altogether time, location and activity dimensions each had 5 separate students who all ran the applications which looked identical to one another, apart from the settings properties. The demographics of the mobile users were of 10 males and 5 female participants, with first year, second year and final year students being amongst the testing group. Once deployed the applications were left to run for the remainder of the term which spans ten weeks from October 5th to December 21st 2012, delivering information and logging the locations and times when the application was used by the students.

5. RESULTS & ANALYSIS

Once the applications had been installed and were active, data collected from the devices was aggregated. The distribution of user interactions with the context aware alerts on a daily basis is shown in Figure 3. Upon initial analysis, it can be seen that there are four peaks across the three dimensions with a highest and dominant peak between the hours of 2-3pm. One obvious point to note from the figure below is that the three dimensions (activity, time and location) exhibit similar trends across the day. Further, given that the profile of users spans a number of academic subjects, the results show that course alerts tend to be read during the hours deemed as ‘office’ and ‘learning hours’. The results of interactions at peak times could be correlated with students using their mobile devise for other activities too such as checking their emails and social networking. It would be premature, as a study, to assume that electronic alerts are read when students are using their mobile devices primarily for social networking. But social networking is a big part of a student’s social life.

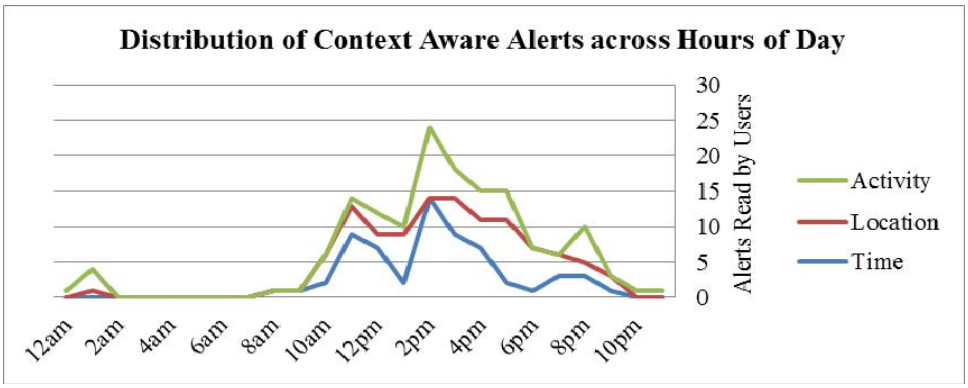

Figure 3. Distribution of user interactions with the context aware alerts across each of the hours of the day.

Figure 4 provides a density map of the locations on campus in which students used the application to interact with an alert. The y axis title being 'alerts read by users' is the aggregated amount of occurrences when an alert from VLE has been read by a user on the mobile. The time based application provided the highest density across the whole of the campus, with all areas covered including residential, informal and formal areas across the entire university. Alternatively, both location and activity alerts were only interacted with in certain areas across campus, mostly central in the heart of campus. It does have to be noted that activity was the only dimension which recorded interactions off the campus environment, demonstrating the dimensions ability to provide the true concept of flexible learning.

Figure 4. Choropleth of Alert Interactions across the campus

Further, it does appear feasible to argue context aware alerts do provide information ubiquitously for keeping students up to date with their courses. Yet the majority of locations where the mobile interactions were situated fall within the typical boundaries of campus perimeters. This confinement of 'learning spaces' is even more apparent for the locative and activity aware applications.

6. CONCLUSION & FUTURE WORK

This study focuses on answering what context aware alerts can inform us about the time and location of users when 'flexible learning occurs'. Although the study has created an insight into user behavior with context aware alerts, a longitudinal study would be necessary to validate the user patterns which have been found so far. Such issues as the seasons could be an important factor as activities and location frequencies may change when the weather improves. For further research the same case study must be carried out in warmer, milder weather to ensure a balanced perspective of user behavior with the alerts. Another issue affecting the mobile interaction areas may be cultural with students possessing a belief or biased towards 'formal learning' areas being the only learning spaces they perceive in a campus environment. Future work should address the reasoning as to why the usage trends as seen in the results occur in all three types of mobile application, this would provide students own perceptions as to why their usage does not fully exploit the concept of flexible, anytime - anywhere learning.

Context aware alert applications have the potential to sustain student engagement with their modules, and provide an innovative method for accessing VLE information away from conventional learning spaces. This study has shown context awareness, especially location and activity can be utilized as information delivery mechanisms; although to what extent needs to be investigated in regards to both pedagogical theory and underlying user reasoning.

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TABLET COMPUTERS ON TRIAL: A TRANSFORMATIVE FORCE IN EDUCATION?

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ABSTRACT

In this paper we present the results of an evaluation study of a development project for the introduction and use of tablet computers (iPads) at the lower secondary level in Nordlinga school, a compulsory school in Reykjavík. In the study, we assess the impact of the use of tablet computers on instruction and students' learning in grades 9 to 10, and on school development in Nordlinga school. First results show that that the project came to a good start, despite some differences that the school had with city administrators and technical problems in the beginning. Most students brought their tablet home and used it for formal, as well as informal and non-formal learning. The introduction of tablet computers enabled access to a variety of software for learning, tools and games. It stimulated communication and collaboration. Products of learning increasingly involved multimedia elements and networking. The study indicated increased satisfaction, interest and independence of students in learning, development of individualized learning strategies, increased student engagement and an improved use of class time. Teachers felt that the use of tablet computers stimulated their professional development and enhanced their work satisfaction. Parents were generally supportive of the use of tablet computers and considered it important that the school could continue to invest in new technologies for learning. Indications were of insufficient availability of learning materials in Icelandic and a start of co-configuration of partners to remedy the situation. The evaluation revealed some weaknesses, challenges and opportunities for further development.

KEYWORDS

Tablet computers, mobile technologies, school development, 1:1 pedagogy

1. INTRODUCTION

In 2012 Nordlinga School in Reykjavík Iceland started use of tablet computers (iPads) in teaching and learning. This pioneering development project was initiated by a team of teachers in the school who planned the project and involved collaborators from the Reykjavík municipality, the National Centre for Educational Materials (NCEM), Apple, and University of Iceland. The project's duration is January 2012 through June 2013. One cohort of students completing their 9-10th grade (15-16 year old) each got a personal iPad for learning in school and at home, which was used in most subjects (Icelandic, English, Danish, Social Science, Natural Science and Math). The authors of this paper are evaluating the project and have published an interim report (Jakobsdóttir et al., 2012) after the first semester. Additional data has been gathered in the second semester. An emerging picture of this case will be presented here.

During the past years financial difficulties have affected the Icelandic educational system in various ways. In many schools, for example, funding has been severely cut regarding purchases of computers (Jakobsdóttir et al., 2013). At the same time the fast development of mobile technologies, including tablet computers and smart phones, has opened up new and interesting avenues which schools and educational systems across the world have started exploring with the hope of enriching and improving teaching and learning for their students. Private ownership of mobile devices has increased, but the educational system appears to be lagging behind in mediating technical knowledge and competences, with many schools limiting students' options in this respect and even preventing them from using social media and mobile technology at school.

The background to the project connects historically with the establishment of Nordlinga School. As a new school it was entitled to equipment budget, but had to seek approval and delivery from the centralized ICT center of the city. The headmaster instructed teachers to make a 'wish-list' and teachers opted for iPads tablet

computers introduction in the 9th grade, to be assessed in 2 years time, when the students would complete their compulsory education. The City of Reykjavík rejected the request and this delayed the start of the project. The schoolmaster gave it full support, as did Apple and other partners that showed an interest in the project. The teachers' vision was based on the school curriculum 'to provide every individual with learning conditions, so that he or she may, on their own terms, develop and thrive, and graduate from the compulsory school as an independent, strong, but not least, a happy individual' (Norðlingaskóli, 2012b). The teachers had already experimented with making digital learning materials and sound books, with the intention to make learning more interactive and individualized, in accordance with student needs. To counteract the rejection from the city center teachers blogged about the problem (Pétursson, 2011), this along with headmaster's support seemed to turn the tide, as Apple consequently decided to loan a few iPads to teachers and the NCEM offered to provide learning materials as PDFs. The city and its IT Centre then decided to come aboard and provide their expertise in digital technologies and system management. The school later purchased the tablets for the project. The University of Iceland – School of Education was consequently invited to join as a research partner. A formal agreement was made for a three-semester collaboration.

2. THEORETICAL FRAMEWORK

Improved access to the Internet, learning materials and information has gone hand in hand with increased availability of new technologies and this has encouraged a steady development in blended learning, where net-teaching and face-to-face teaching is interwoven. A recent report gives an overview of several teaching models that have been evolved in USA at the primary and secondary levels (Staker, 2011) and it indicates a rapid development in mobile learning with digital equipment. Bonk predicted that an increased emphasis will also be put on production of content for these devices, piping for the content, and school culture that emphasizes participatory learning (Bonk, 2009). Initiatives of co-design of learning materials (Jenkins, 2012) and sharing of open content (OER Commons, 2012) is now an open path for educators to follow, in open learning networks (Rudd et al., 2006) where participants cooperate on creation of new meaning and knowledge. Recent developments in mobile and distance learning have caused a blur of the boundaries of learning in and out of school. Siurala (2006) has distinguished between formal education, informal learning and non-formal learning:

Formal education: institution-based, structured, hierarchically and chronologically graded, teacher/trainer-centered education which emphasizes objectivity of knowledge, memorizing and aims at certification.

Informal learning: learning in everyday life, which does not aim at certification but where a diversity of actors each with their own intentions imposes meanings on the learner.

Non-formal learning: learner-centered and practice-based learning process which emphasizes intrinsic motivation, social context of learning, and the usefulness of knowledge, and aims at identity growth, social change and integration into society. Learning is voluntary, involves conscious educational aims and may be credited. (Siurala, 2006).

The informal learning happens daily without any specific objectives, but the non-formal learning is being initiated by the learner and is driven be inner motivation, with objectives set by the individual. Blurring of boundaries in learning (formal, informal or non-formal) may enable individuals to reach out, disseminate his/her experience, knowledge or skill and to learn from others. The term participatory learning 'involves exploring information and concepts within a community of learners who all engage in making and discussing through enquiry'... 'Sharing knowledge from aspects of their lives'... making the discussion more meaningful and relevant (Jenkins, 2012). Learning environments are increasingly characterized by participatory, interactive practices (Kumpulainen et al., 2010).

Collaborative approaches take on different forms and are described in terms like, interagency, multiagency or partnerships (Lloyd et al., 2001). Loyd et al. describe different levels of collaboration further:

Interagency working: more than one agency working together in a planned and formal way, rather than simply through informal networking (although the latter may support and develop the former). This can be at strategic or operational level.

Multiagency working: more than one agency working with a client but not necessarily jointly.

Multiagency working may be prompted by joint planning or simply be a form of replication, resulting from a lack of proper interagency co-ordination. As with interagency operation, it may be concurrent or sequential. In actuality, the terms 'interagency' and 'multiagency' (in its planned sense) are often used interchangeably.

Joined-up working, policy or thinking refers to deliberately conceptualized and coordinated planning, which takes account of multiple policies and varying agency practices. (Lloyd et al., 2001).

In the case of Nordlinga school the formal contract entered into signals the arrangement of interagency working, both on a strategic and operational level. Warmington et al (2004) term this collaboration as co-configuration: 'a form of work oriented towards the production of intelligent, adaptive services, wherein ongoing customization of services is achieved through dynamic, reciprocal relationships between providers and clients. For resolving tasks crossing of boundaries are often necessary, as are changes to structures or removal of hindrances that impede development. Lloyd et al. quote recommendations of a 'Making it happen action team' on ways of overcoming professional, organizational and cultural barriers and identify three types of barriers:

Structural and functional barriers – fragmentation of public services because of range of organizations involved in their delivery; agencies structured around the services to be delivered rather than the areas or groups served.

Process barriers – inflexibilities caused by the financial procedures of agencies; the processes of some central government funding which encourages short-termism and forced partnerships.

Cultural barriers – each profession, each organization can have their own way of doing things and their own sometimes ill-informed views of the other organization and professions with which they deal.

The interagency working can contribute to building quality study environments, but barriers can easily impede or prevent development towards this aim. In the case of the Nordlinga school project the balance between interagency working efforts and barriers confronted will impact the quality and results of the co-configuration.

3. METHOD

In this evaluation study, data were gathered with quantitative and qualitative method. Participants included: Students in one whole cohort. There were 20 girls and 9 boys in the first semester (spring 2012) of the project and 21 girl and 9 boys the following year. There were also teachers and support staff (grade 8 to 10). In the first semester 4 men and 4 women, and the same core group with some changes the following semester (fall 2012). Of the eight there were six teachers teaching Icelandic, math, English, social studies and science, but teachers of art, crafts and sports for this cohort did not take part in the first phase. The teachers were in the age group 26-45 years, most of them with teaching experience of 4-6 years and ICT experience of 1-6 years. In addition, representatives of the collaborating institutes and companies (two from NCEM, one from Apple, three from the Reykjavík municipality) participated in the study. Table 1 gives an overview of the methods used to gather data for the evaluation study. Six graduate students assisted in the data gathering and analysis. A research and evaluation of apps was carried out in march/April 2012 during the first semester, using the Walker-Schrock rubric (Schrock and Walker, 2011) and again during the second semester, in November.

Initially, teachers and students confronted some minor technological hindrances (firewall, wireless connection, saving of data) that were quickly resolved. Teachers managed the systems of communication and used Gmail and Facebook to organize communication with students and parents, but the content produced on the tablet computers was not saved on the city's systems. Instead the school made use of the iCloud and took charge of arrangements of learning materials and student project work. Care was taken to introduce the computers and teaching plan to both students and parents, whose majority supported the project from the start. Teachers also created a separate Facebook group and a website to be able to inform those interested regularly about the project and to disseminate their experience and new ideas (Pétursson and Gudmundsdóttir, 2012). The ICT Centre's management chose low spec iPads that did not have possibilities of a 3G connection, without consideration to future use and school policies. The decision was taken, it seemed, without much consideration to school policy or students and teachers' needs.

Table 1. An overview of the study procedure: Time of data gathering during 2012.

Semester	Months	Participants	Method
1	March	29 students	Nine group interviews
	April		(2-4 students per group, girls and boys separately)
	April	6 Teachers (subjects),	One group interview
	April	Head teacher, special ed. teacher	Two individual interviews
	April	All students and teachers	Two observations, school visits with video recordings
	April	Students (10 students 33%)	Software (apps) survey and evaluation
	May-June	6 Representatives from three collaborating parties (Reykjavík, Apple, and NCEM)	One interview per institute/company involving one to three persons
	June	Parents, students and teachers*	Surveys based on EUN (European Schoolnet, 2012)
2	November	30 students	30 individual interviews with video recordings and photographs (screen shots)
		All students and teachers	Observations during four school days during one week included video recordings.
	November	Five Teachers (subjects)	One group interview

*Parents of 21students (72%) participated in the parent survey, 14 students (48%) in the student survey, and 5 of 7 staff members (71%) who were teaching during the spring semester.

4. RESULTS

4.1 Participation – for Teaching and Learning

The teachers used a variety of tools and software, but none of them used game devices or games. They employed "flipped teaching" (Techsmith, 2012) and collaborated on making their own teaching/learning material, employing new tools, like Teacher's Pal, iBook Author, Educreations and various productivity tools. Teaching plans included both individual tasks and collaboration projects and various learning tools were used to assist students to plan their own learning. Teachers put emphasis on peer learning and learning from their students. Teachers also established partnerships with individuals and agencies outside the school. The majority of the teachers indicated in a survey that they were very keen on taking part in the project. They were active in seeking out events relating to professional development and tablet computer use, as well using social media to further their cause.

Teachers at Nordlinga school all agreed on that their school organization was well suited to teaching with tablet computers. This was in contrast with the results of the European Schoolnet survey on use of laptop computers, where only 64% of teachers agreed to this. The Icelandic teachers were, on the other hand, unsure, or disagreed with, that the school offered enough support for harnessing the tablet computers, while 56% of the European teachers agreed to this. Teachers felt that the use of tablet computers in Nordlinga school contributed to their satisfaction at work and stimulated their professional development. They considered their work more productive and diverse than before.

Teachers noted an increased student interest, independence and engagement in learning. They also noticed acceleration of learning processes, increased efficiency of students, which relied partly on the steady feedback that the use of tablet computer enabled. Problems mentioned were students' time control difficulties in the beginning, as well as their insecurities, when new technologies and learning methods were employed. The tablet computer made their work easier, as it enabled personalized learning, and "flipped-teaching" method gave more time to attend to the needs of each student and attend to problem solving in class. The teachers also mentioned improved teacher-student communication and among themselves, e.g. on learning designs and plans. Various other benefits and development possibilities were mentioned, e.g. creating own learning materials and even new apps.

The students already had some experience with new technologies and the group had considerable differences in social and learning status. They expressed confidence with mobile technologies in the survey and 86% of them had an additional access to a laptop computer at home. Students participated in a short course delivered by Apple and were encouraged to bring their ideas on learning and tablet use to the table. They could choose their own apps. The use of the tablet computers was voluntary and all students, except

one, preferred to use them. They received one lesson each week on mobile technologies, where a teacher also introduced new apps. The ownership of the computer was transferred to the students and all except one computer were in good order, by the end of term. A contract was made with parents on home use. Interviews with students indicated an increase in self-directed learning and an active participation in choosing their own learning content and tools. Home use appeared to decrease the need for playing games at school and using social media websites during school hours, but provided opportunities for home study. Students indicated in interviews that it was relatively easy to get support from peers and teachers on issues of use of the tablet computers and learning.

The AppStore and Open Source depositories offered a great variety of learning content, learning software, games and tools. A third of students participated in a survey on apps they used (43 apps recorded in march/April) and this was mirrored against learning material on offer from NCLM, school schedule and national reference timetable (Ministry of education science and culture, 2012). It revealed shortages of learning content in the Icelandic language, specifically, in some disciplines, such as the arts and vocational studies, and an increase in the availability and use of lesson/learning planning tools and productivity tools. The evaluation, using the Walker-Schrock rubric showed relatively high scores for curriculum connection/relevance, user friendliness and student motivation, but lower on other features.

Students resolved their tasks, not so much with texts and images, as before, but increasingly, with various media tools and expressive interpretation. The students were asked about which learning environments and tools they used. The results are shown in Figure 1. The answers indicate that the students use learning software of choice nearly as often as they use digital textbooks, and an array of tools, games and other digital resources. It is also noticeable that their use of communication tools, games, social media websites and collaboration tools is on a similar level, both in and out of school.

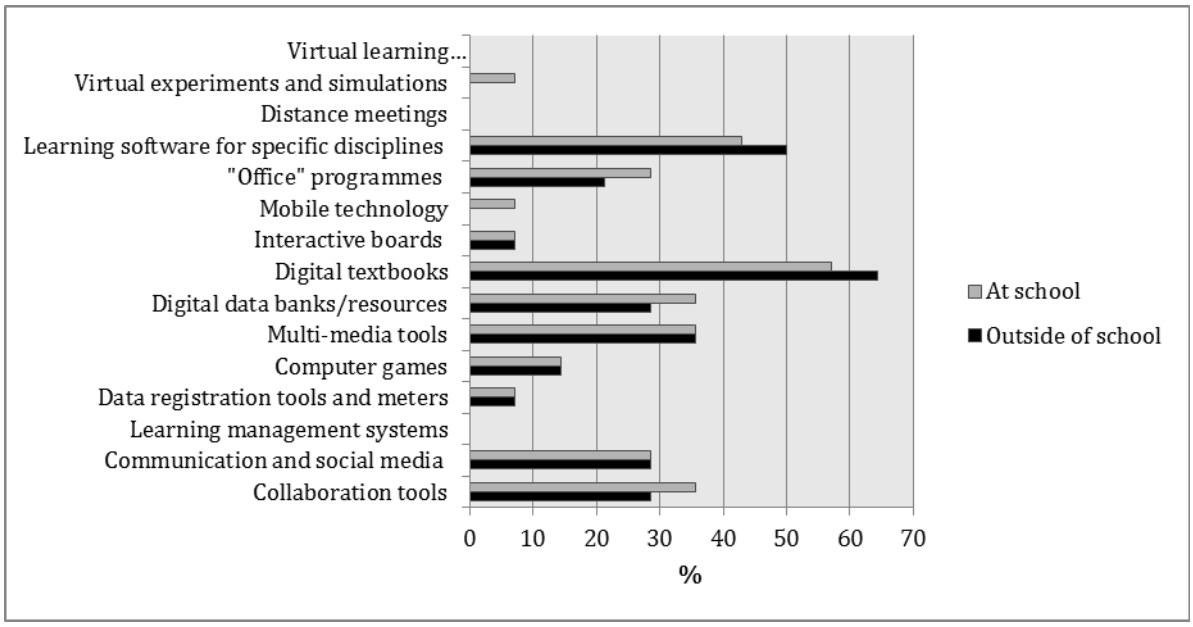

Figure 1. Students' use of tools and learning environments, in and out of school.

Schoolwork was taking preference, but interest areas, planning own learning and sports were also high on the agenda. Students were also asked in the survey if they used the tablet computer to learn about something that did not relate to schoolwork. Around 50% indicated that they sought information on their interests, 42,9% said they tried to develop skills that related to their leisure interests and a third indicated an interest in current affairs, looking for in-depth information on school tasks or on subject not taught at school.

Students were also asked about the impact tablet computer use had on certain issues relating to schoolwork. The results can be seen in Figure 2. These responses indicate that students seem to enjoy schoolwork more than before and that individualized learning is taking hold. It also seems to have positive effects on various aspects of learning and engagement.

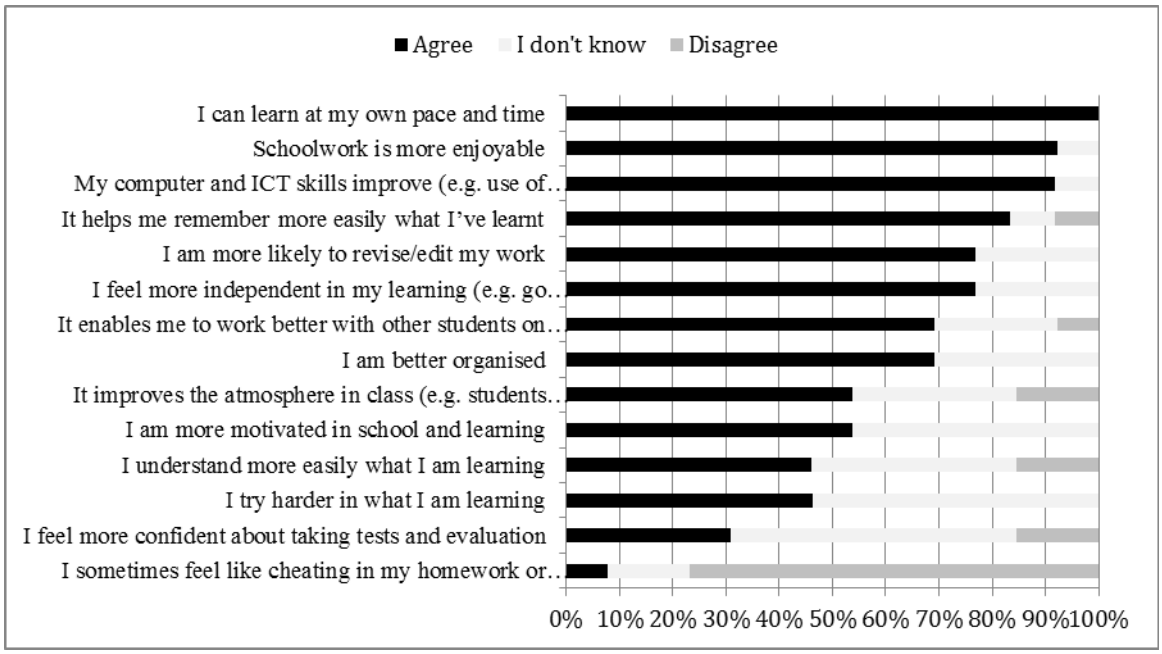

Figure 2. Student's opinion on the effect of using tablet computers

Parents were positive towards the school applying 1:1 pedagogy and 71% thought that the school should continue to invest in new technologies. They took interest in their children's computer activities and 43% of students said that they discussed the use of the tablet computer with their parents at least once a week, 14% almost every day, 14% rarely or never (21%). Relatively many in the student group said that they had helped adults in their family to use the tablet computers (64%). Around 38% of parents indicated that they would like more information on the use of the tablet computers with their children, or on technical matters or support from the school (14%). 92% of parents acknowledged that their children were more proficient in using digital technologies, could learn at their own speed (90%) and that their children's' interest and participation in learning had increased (90%). Neither parents nor their children reported many negative issues relating to the use of tablet computers, but some parents worried about ergonomic issues and a few students said that hand-writing was difficult and complained about eye-pain.

Partners took on their own supportive tasks, either on school/teachers' demand or encouraged by the collaboration that was formally established with a contract and followed up during the project phases with meetings. The level of involvement differed somewhat; Apple and NCLM paid regular visits to the school, sharing their expertise, support services and learning materials; the City's school division and IT centre's assistance and communication was crucial in the beginning of the project, but seemed to vane later and some of their support offered became redundant. Opportunities for extended collaboration arose, such as on development of content and learning materials with NCLM, but new incentives also surfaced to look for partners, for cooperation on assessment and various learning tasks. NCLM appeared willing to learn from teachers, to learn about their needs and to collaborate on learning materials, teacher guides and learning tasks. According to NCLM representatives most schools currently do not call for digital materials, but they estimated that increased use of tablet computers might call for "interactive digital material – as it was the future".

4.2 School Vision, Curricula and Policymaking

Nordlinga school (Norðlingaskóli, 2012b) puts great emphasis on the school taking advantage of its natural and cultural environment, and that education and welfare of students is a shared task of the home and school, that builds its work on mutual trust, shared responsibilities and reciprocal information exchange. Its school curriculum (Norðlingaskóli, 2012a) emphasizes meeting individual students needs, but also developing social competences, collaboration and team work at school. The school runs a progressive educational policy, wants

to create an encouraging work environment for staff and students alike, and to offer teachers opportunities for continued professional development. The school also emphasizes teaching art and vocational disciplines.

A comparison with Reykjavík city school development plan (Reykjavíkurborg, 2010), and the new main curriculum from the Ministry of Education (Ministry of education science and culture, 2012), revealed that the project's objectives were in good keeping with school vision and curriculum. The national curriculum rests on the following main pillars: literacy, sustainability, health, and welfare, democracy and human rights, equality and creativity. It also advocates distributive responsibilities for schools and teachers, a call to which teachers at Nordlinga school have responded. The research revealed differences between the school vision/national curriculum and objectives of the Reykjavík city's IT center. The national curriculum emphasizes that "school work "needs to be in constant flux" and that "changing circumstances and technical innovation demands changes". It stresses that "cooperation and collaboration are a "key issue in successful school development" and advocates reversal, from centralized governance to distributive responsibilities. Reykjavik city's IT centre, on the contrary, has objectives to go from distributive management to centralizing and uniformity, with the aim to handle complexity and volume and to secure efficiency (Hjörtur Grétarson, 2011). These objectives seem irreconcilable with those of the school and the main curriculum. Interview response indicated potential changes in the IT centre policy, as tablet computers were increasingly used by different professionals in the city services, although economic conditions are hampering renewal of computers in the school system.

5. CONCLUSION

The Nordlinga school's initiative to introducing tablet computers and 1:1 pedagogy can be seen as an attempt to create a learning ecology, where both teachers and students are learning to tackle new devices and learning tools, and where new ways of organization, learning strategies, methods and content are forming for the benefit of education. A strong vision and willingness to collaborate has enabled the teachers and the headmaster to build a framework for supporting progressive school development, to introduce 1:1 pedagogy, as well as a collaborative learning scenarios for students and teachers. Furthermore, it has influenced establishment of interagency working with parents and partners, on the periphery of the school setting. Although the school vision is not entirely compatible with some of the partners, collaboration and an ongoing dialogue has been established to drive the development. Challenges can be observed in keeping a fruitful dialogue and interagency working going, and providing results. Shortage of resources and development of technical infrastructure for the tablet computers could test the collaborative effort. Expansion of the project to include more students and other teachers/peer collaborators, could bring challenging tasks. Developing teaching methods and learning aids for students with special needs is an additional challenge.The largest gain can be seen to be the increased engagement and enthusiasm in students' learning. Several testimonies to this can be noted, such as:

- increased satisfaction, interest and independence of students in learning
- development of individualized learning strategies
- development of informal and non-formal learning, out-of-school activities
- developing networking, communication and collaboration competences
- aquisition of technical competences, multi-media techniques and increased media-awareness
- students' broad choice of software for learning, tools and games

Various opportunities can be observed at this point in the project. One has emerged for developing the partner collaboration further, especially in the field of content and learning tools. Others are less obvious or developed, such as collaboration with software developers, in the field of edutainment and learning assessment. Learning opportunities also exist for using iPads in outdoor teaching and learning, for gathering digital data in fieldwork.

Further research interests surfaced during the course of the project. The most important are self-directed learning of students and teachers and their agency. So are the mechanisms and potential of interagency working for expansions of learning environments and the interplay between developing pedagogy and students progress/results. The results have been positive sofar, but it would be desireable to study long term effects, for example to examine if a potential novelty effect will wear off with time.

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DEVELOPMENT AND USE OF AN EFL READING PRACTICE APPLICATION FOR AN ANDROID TABLET COMPUTER

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ABSTRACT

This paper reports on the use of an English-language reading practice application for an android tablet computer operating system with students who are not native speakers of English. The application materials for vocabulary learning in reading-passage contexts were created to include words from a database of low-frequency and technical noun-verb collocations which occurred frequently in certain documents related to the study of international affairs: thirty English-language annual reports of United Nations organizations found on official websites; and English-language annual reports and other articles from the websites of twenty international non-governmental organizations. The learning materials were used in an English for specific purposes course intended to support the reading skill development of students studying international affairs at a university in Japan. Research showed that use of the learning materials had three positive influences on students' study behavior: the students' reading speed increased without a loss in comprehension; the students reported that they enjoyed the reading practice with the mobile tablet computer; and they appreciated that it had some merits that differed from reading practice in hard copy formats that may help improve reading skills.

KEYWORDS

Tablet computer, Vocabulary learning, Reading practice application, English for specific purposes (ESP), the study of international affairs

1. INTRODUCTION

Students who are in the Department of Global Affairs at a university in Japan have four English as a Foreign Language (EFL) courses in the core compulsory curriculum during their four years of university studies. These four courses are English for general purposes courses. Although these students do not major in English language studies, many of them are expected to have high levels of English proficiency for study and for career purposes.

The focus of their studies, in mainly Japanese-language compulsory and elective lecture courses, is on three areas of international affairs: International Relations, International Business, and Global Regional Studies. These courses use English as well as Japanese readings. Courses in these three areas could be strengthened by the creation of materials that promote the learning of unknown words that occur frequently in English international affairs texts; and by requiring students to carry out course learning tasks, such as reading English texts, with the target vocabulary, in order to make analytical oral and written reports using the new vocabulary. There is a proposal to establish English for specific purposes (ESP) courses which would be linked to Japanese-language international affairs courses and replace the current English for general purposes courses.

Accordingly, in order to investigate an approach to vocabulary learning in the proposed ESP courses, as a first step, reading passages on International Relations and Global Regional Studies topics were written for a mobile android tablet computer operating system. The key words of the reading passages consisted of the words on a 550-word English vocabulary list of low frequency and technical noun-verb collocations which was compiled for this project. The words on the vocabulary list were selected, according to teachers' views

on the words' usefulness in international affairs courses, from the first stage of this project's database of commonly occurring non-verb collocations taken from a corpus of approximately 1.3 million words drawn from thirty English-language annual reports of United Nations organizations which are accessible on official websites; and the English-language annual reports and other articles from the websites of twenty international non-governmental organizations. These documents were chosen to develop vocabulary and reading learning materials for international affairs ESP courses for two reasons: 1. these texts are related to required readings used in International Relations and Global Regional Studies courses; 2. the English texts are written for an international audience which mainly includes native speakers of the world's other languages.

1.1 English for Specific Purposes

English for specific purposes was formalized as an area of EFL study in the early 1960s (Johns 2012). In this project, ESP was defined as an approach to EFL teaching, adapted from views described by Anthony (1998) and also Dudley-Evans (1998) with the following characteristics: 1. ESP is defined as EFL study which meets the specific needs of the learners in a specific discipline, i.e. international affairs 2. ESP makes use of the underlying methodology and the topics of the discipline it serves, i.e., reading original texts of international organizations 3. ESP is centered on the language appropriate to these topics in terms of the grammar, lexis, register, study skills, discourse and genre. In this case, the special and common vocabulary of the major organizations engaged in international activities.

As the ESP field has evolved, the focus of teachers' attention has moved away from the transmission of grammatical and lexical knowledge to how knowledge is delivered to the learner. This shift of attention has transformed ESP into a strongly learner-centered and learning-centeredness field (Gatehouse 2001). ESP research has, in recent years, looked deeper into the actual acquisition of language. What motivates learners to acquire ESP knowledge and what needs do they have? What strategies are employed by ESP learners? These questions are central matters in the design of ESP materials, as this area continues to be refined and developed further (Gatehouse 2001, Johns 2012), especially at the university level where students are expected to have already achieved general English proficiency.

In terms of vocabulary learning, ESP texts are thought to be more accessible for learners, who have a solid understanding of the knowledge and use of high frequency words, if they are provided with opportunities to study and use low frequency words, including academic and technical vocabulary. It is important to keep in mind that because these kinds of words are required for both receptive and productive use by the ESP learner, and moreover, that because no matter how advanced their English level is, vocabulary learning in general is considered to be one of the most challenging and on-going parts of language acquisition, the learning of specialized ESP vocabulary should be investigated by the development of new teaching materials and methodologies.

Nation (2008) states that ESP vocabulary learning challenges arise partly from the French, Latin and Greek, origins of some ESP words which have different stems and affixes from most high frequency words. Nation also explains that a key factor in vocabulary acquisition is repetition of exposure to new words and expressions for better recall and retention; however, more specialized vocabulary occurs less often in the lower-proficiency levels of language learning, and thus, also in English for general purposes textbooks. Therefore, the field of ESP is not only concerned with delivering relevant and authentic content to the learner, but also with the teaching and learning of low frequency and technical vocabulary.

Instructors and course designers for ESP must look carefully at the needs of learners, assessing language use and how to assist learners in acquiring and transferring new words into productive use. With the recent rapid developments in information technology in education, a range of new educational tools and materials have become available. When the needs of the learners in ESP courses are based around specific language functions in specific situations, learning materials that can immerse the learner in the situation they find themselves in, and in the required language, would be of great value within ESP (Belcher 2006).

1.2 Applications developed for ESP Courses

The reports of the following four research studies on projects in different parts of the world which developed and used mobile computer-based ESP applications are relevant to this study. Hoven and Palalas (2011) conducted a study in Canada that focused on the problem of making ESP course materials that meet the needs

of learners, particularly when the need is work-related. They reported on two adult professionals who were learning occupational English for accounting. The two learners had high-proficiency general English skills, however, they were lacking in the specific English skills needed for accounting. A blended learning course, a combination of in-class learning activities and out-of-class computer-based independent learning activities, was designed. An iPodTouch mobile device was used to provide speaking and listening skill learning materials for the out-of-class independent learning activities. The aim of the project was to give the two students more learning opportunities than is usual with conventional classroom-based materials with class-based homework assignments by making it easier to practice independently outside of class in any place and at any time of their choosing.

The content of the course consisted of podcasts and vodcasts based around scenarios connected to accounting. Reading, writing, grammar, and vocabulary exercises with audio quizzes were components of the podcast and vodcast learning materials. There were also links to additional online materials and a dictionary. The materials contained ample repetition of key terms, easy access to definitions to clarify meanings, and an aural spelling practice feature. The participants were given a questionnaire which allowed them to reflect on their experiences of using a mobile device for learning. They reported that they were satisfied with the ESP course because they believed the English skills they needed to work in accounting had improved, particularly in listening.

Song and Fox (2008) carried out a study at a university in Hong Kong with three participants to assess how mobile devices could assist in students' incidental learning of vocabulary for specific purposes by using e-journals and interviews to monitor their learning. These non-native English speaking students were taking courses in which English was the medium of instruction, rather than EFL courses. They used mobile devices with mobile phone capability and wireless access. One participant showed an increase in vocabulary retention, which was attributed to, by the student, to frequent exposure to, and repetition of new words, as well as to the use of the Internet during lectures (a form of 'just-in-time' learning) to get word definitions and thus, achieve better comprehension. The three participants also reported using the notepad application to record new words during lectures, and also from the online reading material which they had downloaded. Other comments reflected student perceptions that the benefits of mobile devices exceeded non-mobile computer-based learning tools which they said were less convenient. The mobile device enabled them not only to access what they required when they required it, but the mobile device was also easier to use for review purposes, as well as for collaborative learning through its capacity to put them in contact with classmates and the teacher to ask questions outside of class time.

Hsu's (2012) study provides an example of how the use of a mobile device was used to assist Taiwanese university students taking ESP courses with field research tasks related to work in tourism. The instructor sent tasks about a local tourist attraction to the students by mobile phone. The students used the mobile devices to conduct synchronous interactions with the instructor to acquire information that was required to complete the field-research tasks. The completed tasks were submitted by mobile phone. The purpose of this study was to improve vocabulary learning by using English for problem solving in a field-research learning environment relevant to actual communication that is required for specific occupational purposes.

Fotouhi-Ghazvini, Earnshaw, Robison, and Excell (2009) created an ESP game for Iranian university students in a computer engineering course. The aim was that by playing a game, they could expose students to, and facilitate the retention of, a large amount of specialized vocabulary that otherwise would be hard to learn using traditional methods. The researchers designed the game so that incidental learning could occur by using iconic visual imagery memory elements. They created a game with the hope that even though the students were exposed to a large quantity of vocabulary items, they would be able to sustain a high degree of motivation due to the dynamic and engaging nature of a game. A mobile phone was used to provide the learning materials to allow the students to access the materials more frequently. The game was based around the basic processes of a computer. The game was set in an interactive city with characters that represented the elements of a motherboard. As the students progressed through the game they could 'visit' different areas of the city gaining computer-engineering knowledge and learning new words in context for better comprehension.

These four studies, although small in terms of participants, offer encouragement that out-of-class vocabulary learning tasks that allow students independence in learning can be facilitated by the use of mobile devices.

2. RESEARCH QUESTION

Would the use of the reading practice application on a mobile device help students read ESP reading passages with low frequency and technical vocabulary which occurs frequently in international affairs documents?

3. DESIGN OF THE APPLICATION

This project involved the development of an ESP low-frequency and technical noun-verb collocation vocabulary list to create reading task learning materials for use as an application on a mobile android tablet computer operating system.

In order to develop the application, we used the ADDIE model, a practical model for the design and development of instructional materials which centers all component processes in a holistic systematic planning environment. The ADDIE model has five phases: Analysis, Design, Development, Implementation and Evaluation; each phase has an outcome that naturally leads into the subsequent step (Gagne, Wager, and Keller 2005).

3.1 Students' Needs Analysis

26 second- and third-year students in the Department of Global Affairs at a university in Japan, voluntarily participated in the study. The participants were asked five open-ended questions: 1. What type of words do you want to learn? 2. What kind of international affairs texts do you want to read? 3. What kind of resources do you use in order to get information about the international affairs topics which you are interested in? 4. How do you use the knowledge that you obtain from the texts? 5. What kind of work do you want to do after you graduate?

As for Questions No. 1 and No. 2, all the participants answered that they wanted to learn initialisms, acronyms, and words and phrases which are typically used in the publications of the United Nations, international non-governmental organizations, and other organizations referred to in the texts and lectures in their courses in various aspects of international affairs. They said they wanted to read the aforementioned publications; however, they found the vocabulary and the concepts expressed by unfamiliar expressions difficult. As for Question No. 3, all the participants answered that they preferred to use search engines such as Google or Yahoo as their primary information resources, rather than the traditional hard-copy texts available in the library. The answer to Question No. 4 and Question No. 5 was that the knowledge from English-language international publications would be useful in the research for their graduation theses as well as for the work some of them hoped to do which would involve international communication in English.

3.2 Design of the Application

In order to meet the needs of the students, the application was designed to have the following two functions: 1. to encourage students to look up the international affairs vocabulary on the ESP vocabulary list, including initialisms and acronyms, and to present to the students the meaning and the pronunciation of the specialized vocabulary; 2. to highlight the vocabulary on the ESP list in the reading passages prepared for this project in order to present to the students the meaning and the pronunciation of the target vocabulary.

3.3 Course Design

In order to accomplish the primary aim of our project to help students read international affairs passages, an elective ESP course was added to the curriculum in which students read texts in class on the screen display of a mobile android tablet computer with a Wi-Fi Internet connection. The students were required to read as many passages as possible. The students were required to write a summary in English of each passage that they had read on a report sheet which was handed in to the teacher.

The following is the procedure of activities in each class session: 1. The students read one reading passage given by the teacher and answered comprehension questions. 2. The students wrote a summary of the text and handed it in to the teacher. The answers to the comprehension questions were given to the students. 3. The students looked for other authentic texts which were related to a topic of the first reading passage that the teacher provided them, using search engines such as Google or Yahoo on the Internet. 4. The students chose one text to read. After reading the text, the students wrote a summary. Steps 3 and 4 of the class procedure were repeated until the end of the class session. 5. The students took the mobile tablet computers home after class. They were free to use the mobile device with its free Wi-Fi connection to review their in-class work, to read other authentic international affairs documents, and to use the mobile device in any way they wished, as long as they took personal responsibility for their out-of-class use, including the payment of any extra costs. They submitted a report on the out-of-class activities the following week.

4. DEVELOPMENT OF THE APPLICATION

4.1 Project Word List

A fundamental way of supporting vocabulary teaching and learning has been to compile word lists of high-frequency words from a large corpus of texts. Word lists consist of a learnable number of relatively few words that make it clear to students which words should be learned first and best. West's General Service List of English Words (GSL) selected by frequency of occurrence and by criteria of usefulness from a wide variety of written texts provides information about different meaning senses of 2,000 common words and their comparative rates of occurrence (West 1953). Although about 80% of the words in a variety of written academic texts can be found in the GSL (Nation 2001, Cobb and Horst 2004), it was decided to use the more-recently compiled British National Corpus (BNC) to create the word list used in this project because the BNC is newer, larger, and also an on-going project (Nation 2004, Nation 2006). Coxhead's (2000) 570-word Academic Word List (AWL) was also used in creating our word list. The AWL's usefulness is based on the fact that 8.5% or more of the words in academic texts can be found on this relatively short list. It was taken into account in the compilation of the project word list that the AWL was created by using the GSL and not the BNC.

There is an argument that in spite of the wide coverage and usefulness of word lists for interdisciplinary academic purposes, discipline-specific vocabulary lists are also needed because academic words vary across disciplines in range, frequency, collocation and meaning (Hyland and Tse 2007) and because some of the words common to one certain field and specific to topics such as international affairs may come from a narrower learnable pool of low-frequency and technical words. It is essential to help students extend their academic vocabulary knowledge because as many as 98% of the words in a text must be known for comprehension (Hu and Nation 2000).

An obvious learning problem with most word lists is that the words have been taken out of the contexts that they were found in. In order to deal with this issue, the list compiled for this project consists of words in the key collocations they were found to occur in. Goto (2007) analyzed the syntactic features of selected English essays in various physical science fields from corpora assembled by the Nagoya Institute of Technology, using 'Machinese Syntax,' a syntactic parser which produces information on base forms and compound structures, part-of-speech classes, inflectional tags, noun phrase markers, and syntactic dependencies. By multivariate analysis, three patterns of noun collocations were found: 1. verb + noun, 2. noun + preposition, 3. noun + noun. In this study, the first of the three patterns was adopted as Akano (2008) claims that a priority should be placed on explicitly teaching this pattern to Japanese EFL students because of the centrality of the verb-noun combination in expressing key meanings, and the value of teaching vocabulary in the tightly conventional patterns which tie words together, rather than teaching new vocabulary as single isolated words on lists

A corpus of English language texts was used to create the word list. The corpus consists of two components in PDF versions formatted for print: 1. annual reports and other major reports of UN organizations 2. annual reports and other major reports of prominent international NGOs. The PDF versions of the reports were converted into texts using xdoc2txt.exe. The bodies were extracted from the texts and lists

of words were compiled. The texts have yielded a word database of 1,262,303 tokens (total number of words) and 28,371 types (different words).

The word list for this project was created in the following way: 1. Words that occurred at a frequency of less than 10 times were removed from the data base. 2. Initialisms and acronyms were extracted from the data base. 3. Words which were included in the BNC most frequent 2,000 word family list (head words plus inflections and derivations) prepared by Nation (2006) were also eliminated from the data base. 4. In addition, the AWL word family list (head words plus inflections and derivations) were eliminated from the data base. One ESP word list was developed with two sections: one section was a list of all of the initialisms and acronyms which occurred in the texts 10 times or more; the other section of the list was a 2,499 preliminary word list of words which occurred 10 times or more and in at least 6 of the 50 documents. From the preliminary word list, nouns with their verb collocations were selected for the final word list. Teachers' intuition about word usefulness was applied to select words for a shorter more learnable list of 550 nouns (with their verb collocations) which were considered particularly useful for international affairs courses.

4.2 Development of the Application

The application has two functions: 1. a dictionary function 2. a function that highlights the words from the ESP international studies vocabulary, including initialisms and acronyms, which are in the reading passages provided by the teacher on the tablet computer and also in Internet texts with URLs listed in the learning materials. Figure 1 is a screen display of an Internet text, with its URL listed in the learning materials, that shows the highlighted vocabulary in an Internet text.

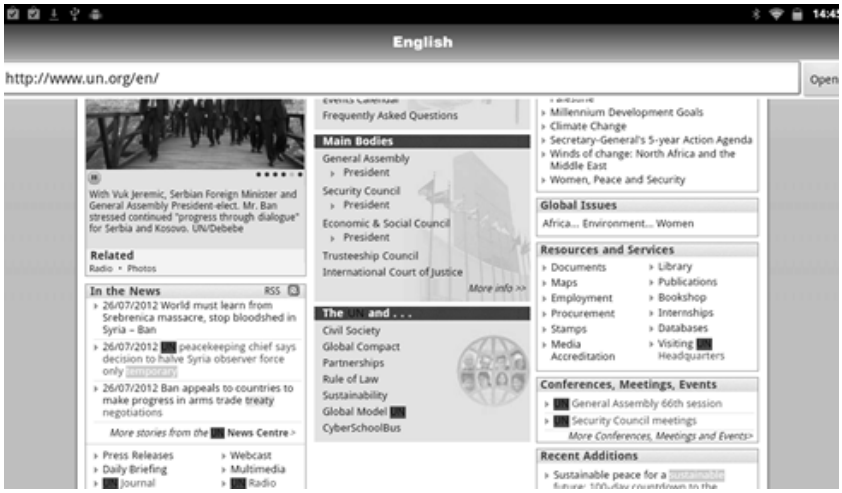

Figure 1. Screen display of an Internet text linked to the learning materials

5. EVALUATION OF THE APPLICATION

The application was used from September 2012 to December 2012. 26 students were enrolled in the course. A comparison was made of the time the participants took to read a reading passage with and without the tablet. A course evaluation was completed by the participants at the end of December.

5.1 Time taken to read an ESP Reading Passage

The participants were required to read one of the reading passages from the project's learning materials at the beginning of October. They were asked to read the same passage at the end of December. At the first reading, the participants were not allowed to use the android tablet in which the project's application had been installed. The second time, they were allowed to use the tablet. Twenty students out of 26 answered 8 or more of 10 comprehension and analysis questions satisfactorily at both readings. The times of students who

had adequate comprehension of the text at the first reading were compared, on the assumption that time spent laboriously extracting the meaning reduced time and perhaps, motivation to read more texts.

A two-tailed *t*-Test was used to compare the times the participants spent reading the passage at both readings. The times at the first and second readings proved to differ significantly ($p < .001$, $r = .87$). Therefore, it was concluded that the use of the application helped the students read the passage fluently. Table 1 shows the results of the comparison of the times spent reading the passage at both readings.

The students reported that they were able to read quickly the second time because the tablet application allowed them to check word meanings more quickly than with a paper-based text. They said that they were accustomed to reading words from the ESP word list in context. They believed that they had become better at making text-based guesses about words and expressions because the ease of confirmation had given them confidence in their reading. The students said that because of the convenience of the tablet they had done more reading in international studies areas than before.

Table 1. Time required to read an ESP reading passage

	n	Mean (SD)
1st reading (without tablet)	20	33.30 (9.70)
2nd reading (with tablet)	20	13.50 (5.52)
Gain	20	-19.80 (11.49)

$p < .001$; $r = .87$

5.2 Student Evaluation of the Course

At the end of December, a student course evaluation consisting of 16 questions was conducted. Fifteen questions were intended to focus attention on the use of the application and one question asked the participants whether reading with the use of the application for the android tablet computer suited their own learning styles. Students were also asked to write their own opinions in an open-ended question on the advantages and disadvantages of reading texts using the android tablet computer. A 6-point Likert scale was used for the responses in order to adequately allow for the expression of a range of participants' feelings about the course. The ratings of 3, 2 and 1 respectively correspond to somewhat disagree, disagree, and strongly disagree; the ratings of 4, 5, and 6 respectively correspond to the ratings of somewhat agree, agree, and strongly agree. Twenty students out of 26 answered the questions. The rate of reliability of the questions was high ($\alpha = .91$). Table 2 shows participants' self-evaluation of their own learning with the application in the android tablet computer.

Table 2. Participants' self-evaluation of their own learning with the application in the android tablet computer

Item	Mean (SD)
1. The application is useful for reading a text quickly.	3.00 (1.00)
2. The application let me read a text faster than I can read a paper-based text using an electronic dictionary.	3.47 (0.84)
3. The application shortened the time spent reading a text, so I could concentrate on understanding the text.	3.47 (0.96)
4. The application is useful for understanding a text.	3.42 (0.96)
5. The application is useful for improving reading skills.	3.26 (1.10)
6. Reading a text with the use of the application improved my reading skills.	3.21 (0.92)
7. I became conscious of the words highlighted by the application.	3.68 (1.23)
8. The application is useful for learning vocabulary.	3.00 (1.25)
9. The use of the application increased my vocabulary.	3.05 (1.03)
10. The Japanese meanings of words in the application helped me understand a text better than the Japanese meanings provided in paper-based texts or in an electronic dictionary.	3.21 (0.86)
11. It would be better to have a paper-based list of the vocabulary highlighted in the application to read a passage.	4.53 (1.07)
12. I enjoy reading texts using the application.	3.84 (1.07)
13. The application motivated me to read other international affairs texts.	2.95 (0.78)
14. I want to continue reading texts using the application.	3.21 (1.03)
15. The use of the application alone will improve my English language skills.	2.74 (1.28)
16. Reading a text with the use of the application suits my own learning style.	3.00 (0.67)

$n = 20$

As is shown in Table 2, according to the response to item 1, on the whole, the participants expressed a neutral uncommitted view on whether the use of the application would improve reading speed. However, when asked whether their own reading speed was faster with texts on the application compared to their reading speed of hard copy texts with the use of an electronic dictionary (item 2) to check the meaning of unknown words they were quite confident that they read faster with the application. Moreover, they had strong beliefs that reading speed was an important factor in improving comprehension of a test (item 3) because of the time it allowed them to think about the meaning of the text.

The students expressed slightly stronger than neutral views that the use of the application would improve understanding of texts (item 4) but when they were asked, more specifically, if their reading proficiency would improve (item 5) they were quite confident that it would. They expressed moderately better than neutral views (item 6) of whether their own reading skills had actually improved.

Five items (items 7 to 11) elicited information related to whether the use of the application was useful for learning vocabulary. The students were somewhat more optimistic than a neutral view that the application was useful for vocabulary learning (item 8) but they did not know whether their own vocabulary knowledge had improved or not (item 9). They were somewhat more appreciative of the value of the way Japanese meanings of difficult English words and expressions were accessible on the application (item 10). They said that they strongly believed that highlighting target words in the context of a reading passage was helpful (item 7); however, they expressed a very strong desire for a hard copy list of the target words (item 11) to supplement the application.

The participants in the project expressed strong feelings that the use of the application was enjoyable (item 12). In contradiction to this view, their rating on whether they used the application to read other international studies texts (item 13) was very close to a neutral 3. This is borne out by the fact that the use of the mobile tablet computer outside of class for vocabulary and reading activities was not common. However, they were more optimistic, at a rating of 3.5, about whether they would like to continue using the application for reading international affairs texts (item 14).

In response to item 15 about whether the use of the application on its own was sufficient, they stated strongly that it was not sufficient. In keeping with that response, the students were moderately sure that the use of the application suited their own learning styles (item 16).

Overall, the students did not express negative views (i.e. ratings below 3.0) about the use of the application and they were quite positive about the impact of the use of the application on their reading speed. Their other responses were quite encouraging considering that the students constantly use mobile devices for other communication purposes. A challenge will be to encourage students to use mobile communication devices for independent study purposes.

6. CONCLUSION

Research showed that use of the learning materials had three positive influences on students' study behavior: the students' reading speed increased without a loss in comprehension; the students reported that they enjoyed the reading practice with the mobile tablet computer; and they appreciated that it had some merits that differed from reading practice in hard copy formats that may help improve reading skills. There is not yet any evidence that the use of the application contributed to an improvement in the reading of international documents by supporting the learning of vocabulary commonly found in the documents of international organizations. However, the project gave no reason to believe that further ESP approaches, using tablet computers, to vocabulary and reading skill teaching and learning should not be explored.

This project's short-term use of an ESP reading practice application for an android tablet computer operating system was, in effect, because of the fundamental successes of the project, a pilot study for on-going action-plan research into ways to help Japanese students build the low-frequency and technical vocabulary necessary to develop English reading skills sufficient for the rapid comprehension of authentic documents of international organizations published in English for international audiences, without relying entirely on native-language translations. It is considered possible that on the basis of ESP vocabulary knowledge and reading proficiency, students may add listening, speaking, and writing skills which will allow them to study in international groups and to have careers in international organizations.

The accomplishments of this project that may likely provide an educational infrastructure for the future developments of ESP international affairs materials include: 1. The corpus of international documents and the database of the most frequently occurring, low-frequency and technical noun-verb collocations which were extracted from the corpus. 2. The list of initialisms and acronyms drawn from the database. 3. The 550 headword noun-verb collocation word list, in sentence context, and also the reading passages which feature words from the word list with comprehension questions. 4. The experience gained from the successful use of an application of original learning materials on a mobile device, an android tablet computer. 5. The establishment of an ESP course for international affairs which was linked in content to texts that are used in other Japanese-language international affairs courses.

In the next steps of this project it will be useful to conduct vocabulary and reading tests to win students confidence and to investigate which materials are effective for a variety of English proficiency levels and for a variety of learning styles. On this basis, e-textbooks which can be integrated into applications for android tablet computers will be designed for vocabulary learning and reading comprehension skill building.

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MOBILE LEARNING APPLICATION INTERFACES: FIRST STEPS TO A COGNITIVE LOAD AWARE SYSTEM

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ABSTRACT

Mobile learning is a cognitively demanding application and more frequently the ubiquitous nature of mobile computing means that mobile devices are used in cognitively demanding environments. This paper examines the nature of this use of mobile devices from a Learning, Usability and Cognitive Load Theory perspective. It suggests scenarios where these fields interact and presents an experiment which determined that several sources of cognitive load can be measured simultaneously by the learner. The experiment also looked at the interaction between these cognitive load types and found that a distraction did not affect the performance or cognitive load associated with a learning task but it did affect the perception of the cognitive load associated with using the application interface. This paper concludes by suggesting ways in which mobile learning (and mobile computing) can benefit by developing cognitive load aware systems that could detect and change the difficulty of the learning task based on the cognitive state of the learner.

KEYWORDS

Mobile learning, mobile Usability, Cognitive Load Theory.

1. INTRODUCTION

Current mobile device use is presenting previously unconsidered problems. Mobile devices are now ubiquitous. The size, portability, battery life and computational power of mobile devices suggest that they can be used for a diverse range of uses in an equally diverse range of environments. Usability, or HCI (Human Computer Interaction), is primarily concerned with "ease of use" and "learnability" (e.g. how easy a system is to learn to use) (Neilsen, 1994). Mobile devices are challenging this notion of Usability as these devices are used in new ways. *Firstly*, mobile devices are used in complex distracting environments and these distractions interfere with the user's cognitive resources. *Secondly*, mobile devices are becoming advanced and powerful and this allows more sophisticated applications to be used on them.

Such applications are already cognitively demanding but the use of mobile devices for learning also brings a much higher demand for cognitive resources. Couple this demand to situations when the mobile device is used in a distracting environment and this leads to scenarios where the user's cognitive resources become overloaded or stretched. Cognitive Load Theory explains how the human mind interacts with instructional materials for learning and has several guidelines that are used to assist in the design of instructional material used for learning. These guidelines suggest methods to discourage extraneous cognitive processes and encourage germane cognitive processes. This paper will present the results of an experiment that demonstrate how mobile learning, Cognitive Load Theory and mobile usability interact.

2. LITERATURE REVIEW

Learning is considered to be the acquisition and development of memories and behaviors, including skills, knowledge, understanding, values, and wisdom. Specifically, from the perspective of the Information Processing Model (Broadbent, 1958, Neisser, 1967), it is the changes made to long term memory, usually schema creation or automation. Learning has traditionally taken places in learning institutions or schools. However, this may not be the best place for learning (Dewey, 1916, Bloom, 1964). In modern times, not only

is high literacy demanded of everyone but the ability to think and reflect is now a valued attribute in the workplace. "Knowing" has shifted from being able to remember and repeat information to being able to find and use it (Simon, 1996). The role of education now should be the development of intellectual tools and learning strategies needed to acquire that knowledge (Bransford *et al.,* 1999).

Mobile learning can address some of these challenges. Mobile learning is defined as *"Learning with the aid of a Mobile device"* (Deegan and Rothwell, 2010a). In this definition a mobile device is simply a computer that is not restricted to a specific stationary environment or location. Specifically, mobile devices can be used in multiple environments, anytime, anywhere. Deegan and Rothwell, (2010a), investigated mobile learning from a Usability perspective and put forward a classification of mobile learning applications based on Usability. Usability is defined by the ISO as "*the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments.*" (ISO 9241, 1998). A usable system should be easy to use (utility) and easy to learn (learnability) (Nielsen, 1994). In recent years the notion of 'ease of use' has been applied to Usability where the general philosophy is based on making things 'easy' for the user. This approach stemmed from work done by Miller (1956) which determined that human cognitive resources were limited.

One of the primary concerns raised during the creation of Deegan and Rothwell's, (2010a), classification was the issues surrounding Cognitive Load. Cognitive Load is the demand for mental resources associated with processing information in working memory. Usability practitioners attempt to reduce the inputs that humans had to process; making things easier (less Cognitive Load) meant making things more effective, efficient and satisfying to use. It was thought that systems that demonstrated a lowering of Cognitive Load would ensure that users were not over-burdened by the system. Computing began to reduce the Cognitive Load in an attempt to remove the burden of choice and thought from the user (Chalmers, 2003). Computer software is now easier to use and it is in part due to this that computer users of today generally have low Cognitive Loads applied to them (Sharp *et al.,* 2007).While Usability practitioners attempted to lower Cognitive load, pedagogues and Cognitive Load researchers were finding that an increase in Cognitive Load could be beneficial for learning. Research reported in Sweller, (1988), Sweller and Chandler, (1994), Sweller *et al.*, (1998), and Paas *et a.*, (2004) etc. argues that our Cognitive Load can and will vary depending on the characteristics of the task and those of the user. Cognitive Load Theory (CLT) was developed to help understand how humans learn effectively with specific regard to problem solving. CLT is defined as being "concerned with techniques for managing working memory load in order to facilitate the changes in long term memory associated with schema construction and automation" (Paas *et al.,* 2004). CLT posits three types of Cognitive Load that affect learners: Intrinsic, Extraneous and Germane Cognitive Load (Bannert, 2002, Sweller *et al.,* 1998): Intrinsic Cognitive Load (ICL) is due to the inherent difficulty of the task, Extraneous Cognitive Load (ECL) is due to distractions not directly related to the task and Germane Cognitive Load (GCL) results in changes to our long term memory due to the task (typically this is schema creation, manipulation, and assimilation). This activity, that leads to changes to long term memory, is directly associated with learning (Sweller *et al.,* 1998).

CLT actively encourages designers to increase the load associated with this schema creation (i.e. the GCL) and to reduce ECL in order to best use the learner's limited cognitive resources and thus improve performance. Usability practitioners' focus on increasing the ease of use of applications is, in CLT terminology, actually a focus on the reduction of ECL. These two contradictory aspects affect Mobile learning; as one aspect attempts to lower Cognitive Load another seeks to increase it. Van Nimwegen (2008) refers directly to this paradox: he questions the assumption that indiscriminately increasing the ease of use necessarily results in better applications. He determines that for certain types of applications it is actually beneficial to make the users' task activities more difficult because this results in deeper thought processes and thus increased learning performance. Hollender *et al.,* (2010) says there is no CLT counterpart in HCI for fostering germane load, perhaps because the goal of HCI is to reduce Cognitive Load (Sharp *et al.*, 2007). However, it is notoriously difficult to measure cognitive load. If cognitive load can be measured it is then extremely difficult (if not impossible) to differentiate between its constituents: ICL, GCL and ECL. There have been advances in measuring the load especially in relation to user centered educational design (Oviatt, 2006), however, little work exists that can accurately measure the different types of load by discriminating between them. This is particularly interesting to Usability and specifically learning applications where one needs to determine what aspects of cognitive load are aiding or inhibiting learning i.e. which aspect of instructional design is affecting the ECL or GCL.

3. MOBILE LEARNING INTERFACES

Without a doubt learning is a cognitively demanding activity. As a result of Deegan and Rothwell's, (2010a) work, the need to balance Cognitive Load for the mobile learner was identified as a serious concern. Subsequently (Deegan and Rothwell, 2010b) presented a model of external sources of Cognitive Load that are relevant to mobile learning (Figure 1). This model acknowledged that Cognitive Load comes from the intrinsic nature of the learning (itself) but also suggested other extraneous areas that can contribute Cognitive Load and affect learning.

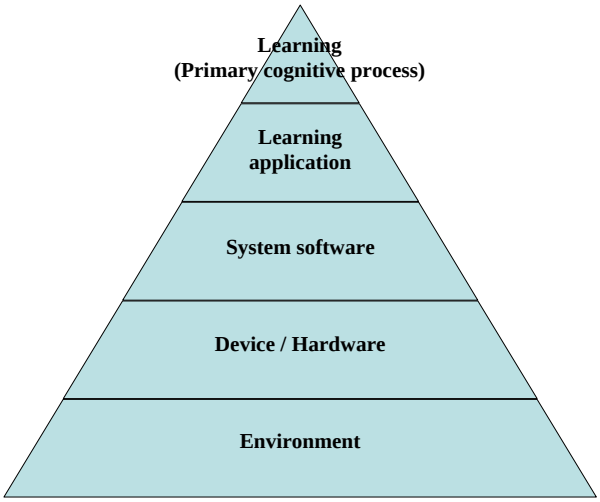

Figure 1. Sources of Cognitive Load

At the top of the model is the actual learning and this represents a small portion of likely Cognitive Load distractions (ECL's), perhaps the material being learned itself causes a distraction e.g. presentation. The learning application interface refers to the application itself and how the user interacts with the application e.g. uses its controls etc. The system software itself can also contribute to sources of Cognitive Load, e.g. badly timed error messages etc. The device could also contribute to Cognitive Load if it is badly designed or too heavy etc. Finally, the environment can contribute to cognitive load, and this represents the largest category of possible sources of Cognitive Load distractions. By combining several methods of balancing Cognitive Load (Kirschner, 2002, Mayer and Moreno, 2003, Van Merrienboer *et al.*, 2002, Sweller *et al.*, 2011) instructional designers can ensure that the learner's cognitive load is at the suitable level with regard to the material being learned. They can make certain that the ICL and GCL of the instructional material is appropriate and make efforts to reduce or eliminate ECL. This addresses the cognitive load at the top of the model, the actual learning.

Usability professionals can make efforts to reduce likely sources of ECL with regard to the application interface itself. However it is unlikely that those associated with the creation of Mobile learning applications will also have complete autonomy to control the cognitive load that is inflicted by the System software or the actual hardware of the mobile device. Attewell (2005) suggested that the technology selection used in Mobile devices varied greatly and therefore the system software and device hardware is deemed beyond the range of control of the mobile learning application developer.

Finally the application developers could make efforts to develop mobile learning context aware applications that are also sensitive to the environment. In this way the cognitive load of the mobile learning application can be altered to suit the cognitive load of the environment. This will be a crucial attribute of a mobile learning application as mobile learning takes place with cognitively demanding applications in cognitively demanding locations.

An early research question was formed that asked how exactly does a cognitive load, inflicted from a distraction, affect a learners performance and is it possible for a learner to distinguish between several different sources of these cognitive loads. Specifically could a user distinguish between the cognitive load

associated with the learning content, the cognitive load associated with the application interface and the cognitive load associated with the environment (e.g. a distraction)? If a user could distinguish between these loads it may be possible for the application to distinguish between the loads also. Developers could then create cognitive load aware applications which could alter the cognitive load that the application inflicts (e.g. making the application easier when a distraction is detected and difficult when the distraction is removed).

4. EXPERIMENT TO DISTINGUISH BETWEEN COGNITIVE LOADS

Traditionally cognitive load based experiments would ask the participant to perform a learning task. This learning task would have a specific ICL, or difficulty, and it may have an associated ECL based on its design. The user then would impose a GCL while completing the task. A total measurement of cognitive load would be ascertained at this stage. Usually one of these loads would be theoretically (as they cannot be measured separately) manipulated e.g. a distraction, that inflicts an ECL, is added to the experiment conditions. Finally another overall level of cognitive load is measured and any change in overall load would be a reflection of the added distraction, yet what cognitive load this distraction affected would not be certain.

This experiment design is different in that it will attempt to measure the "added" cognitive load, as well as the cognitive load associated with the learning task and the cognitive load associated with using the application interface. This experiment will determine if this added load actually effects the performance or cognitive load associated with the learning task or interface i.e. rather than adding an extraneous cognitive load and measuring the overall cognitive load, this experiment will attempt to add an extraneous cognitive load and separately measure it and its effect on the original tasks and loads.

4.1 Method

4.1.1 Participants

104 participants were recruited from the online site Mechanical Turk[1]. Several recent studies have found Mechanical Turk a valid source of participant recruitment for behavioral and user studies (for a full overview please see; Kittur *et al*., 2008, Buhrmester *et al*., 2011, Paolacci *et al*., 2010, Callison-Burch, 2009). In fact, Buhrmester *et al*., (2011) and Ipeirotis, (2010) suggest that the representative demographic characteristics of Mechanical Turk may be at least as diverse and more representative than traditional college or online based recruitments. Each participant was paid $0.10 to complete the task which took approximately 4 minutes. No demographic information was obtained. All participants agreed to give their consent. Participants were not able to complete the experiment more than once.

4.1.2 Materials

Participants were expected to have their own computer and access to broadband / the internet via a computer. The learning task was a series of 10 mathematical problems in which the participant needed to add or subtract three "two" digit numbers. The answer will always be two digits and fall between 25 and 90. Cognitive load was measured using a 9 point Likert scale developed by Paas (1992). This scale is widely accepted as being a very accurate measure of cognitive load (Sweller *et al.*, 2011).

4.1.3 Procedure

The added distraction was designed to bring the learner close to a state of cognitive overload. There were two levels to this distraction, easy (low cognitive load) and hard (high cognitive load). Referring back to Millers (1956) work which suggests that humans working memory is limited, it was decided that this distraction will be a memory task which will run simultaneously to the learning task. The actual distraction is unimportant as long as it inflicts a similar (for the purposes of this experiment) cognitive load on the participants.

For the purposes of this experiment it was desirable to investigate the load associated with the application interface and not the device itself, e.g. the difference between using a mouse and keyboard and using gesture

1 http://www.mturk.com/

based interaction to interact with the application etc. For this reason two versions of the learning task were shown to the participants. A web based version and a web based mobile phone simulator version (Figure 2). The only difference being the application interface i.e. how the information is presented and accessed.

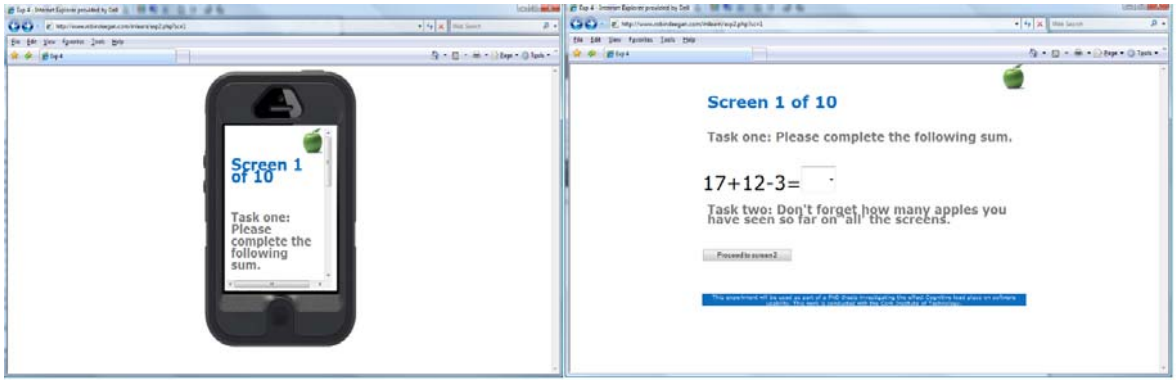

Figure 2. Mobile Simulator desktop app and desktop app

The distraction required the learners to remember how many apples were displayed at the top of various pages (see figure 2) throughout the primary task of completing the mathematical calculations. The low distraction was to remember seven apples over the ten mathematical tasks and the high distraction was to remember seventy apples over the ten mathematical tasks. The participants were randomly split into 4 groups. Group 1 completed the mathematical task with the desktop interface and low levels of distraction. Group 2 completed the mathematical task with the desktop interface and high levels of distraction. Group 3 completed the mathematical task with the mobile interface and low levels of distraction. Group 4 completed the mathematical task with the mobile interface and high levels of distraction. In addition to measuring the cognitive load of the mathematical task and cognitive load of the distraction, the cognitive load of the application interface was also measured.

Experiment hypothesis are as follows. H1: The learner can measure several cognitive loads simultaneously, including loads that the mathematical task, the device interface and the distraction inflict. H2: The distraction will affect the mathematical task. H3: The cognitive load associated with using the mobile interface will be higher than for the desktop interface.

4.2 Results

The analysis focused on the mental effort and performance associated with the mathematical learning task (task1) and distraction (task2) the mental effort associated with using the interface. 54 participants completed the task with the easy distraction (29 with the desktop interface and 25 with the mobile interface). And 54 completed the task with the difficult distraction (27 with the desktop interface and 27 with the mobile interface). Difficulty and interface type with the independent variables with two levels each, respectively. The dependent variables were task1 effort rating, task2 effort rating, interface effort rating, task1 performance, task2 performance. The data was normally distributed, assumptions of variance-covariance and homogeneity of variance were met. As such a two way MANOVA was used to analyze the data.

Using Pillai's trace, there was no combined effect of difficulty and interface on accuracy of task1 or task 2, or the mental effort ratings of task 1, task 2 or the interface, $V=.059$, $F(5,100)=1.247$, $p=.293$, observed power of .43. However the MANOVA for difficulty alone, $V=.131$, $F(5,100)=3.026$, $p=.014$, showed that the difficulty of the task had a significant effect on the dependent variables with an observer power of 0.85. Also the MANOVA for the interface type alone $V=.064$, $F(5,100)=1.37$, $p=.242$ showed that the interface type did not have a significant effect on the dependent variables, with an observed power of 0.46.

Follow up univariate analysis showed that difficulty had a significant effect on task 2 effort rating $F(1,104)=4.991$, $p=.028$ with an observed power of 0.60. This indicates that the difficulty of the distraction affected the distraction rating between the easy group ($M=5.46$, $SD=2.67$) and hard group ($M=6.56$, $SD=2.24$). Surprisingly the difficulty of the distraction also had a significant effect on the interface ratings and interface rating $F(1,104)=5.58$, $p=.020$, observed power 0.65, between the easy group ($M=4.22$, $SD=2.56$) and hard group ($M=5.46$, $SD=2.55$).

4.3 Discussion

Hypothesis 1 was accepted, the learner was able to distinguish between several sources of cognitive load simultaneously. One of the main issues with Cognitive load Theory is that it is very difficult to differentiate between sources of ICL, GCL and ECL, where as an overall level of Cognitive Load can be measured (Sweller *et al.*, 2011). In this experiment the learning task contains both ICL (17+12-3 has an inherent difficulty) and ECL (perhaps the presentation could have distracting elements). The distraction and the application interface are both sources of ECL. However they are simple measured by asking the learner to rate them. This is interesting as it suggests that it may actually be possible to differentiate between the various load types, although asking the learner to do so may inflict another ECL in itself.

Hypothesis 2 was not accepted, the distraction did not significantly affect the performance of the primary task. This was unusual as current research suggests that a high secondary cognitive load can affect the primary performance. Sweller *et al.* (2011, p78) state *"If the primary task imposes a heavy cognitive load, performance on the secondary task deteriorates. In contrast, a lower cognitive load on the primary task can result in improved performance on the secondary task."*

Unfortunately, a performance measurement for "using the application interface" could not be obtained so it is unclear whether the distraction made a difference in the performance associated with this action. As it seems there is a correlation between the mental effort associated with the distraction and the interface type, it is a distinct possibility that there could also be a relationship between the distraction and the performance associated with using the application interface. This possibly serves to highlight the importance of differentiating between the various cognitive loads so that individual relationships between load types can be determined and understood. For example, why did the distraction affect the cognitive load associated with the interface and not the learning task?

Hypothesis 3 was also not accepted, there did not seem to be any significant effect of interface type on mental effort ratings or performance. This is good news for the mobile learning community. However, the actual conclusion may not be that clear. From the graphs below (figure 3) it can be seen that the distraction was more pronounced (although not significantly different) for the mobile interface group than the desktop interface group. Interestingly, the univariate analysis for the effect of *interface type* on *distraction* ratings showed that there was a difference and while it was close to significant, it was not significant ($F(1,104)=3.709$, $p=.057$ with an observed power of 0.48). It appears that the while *difficulty* had an effect on the *interface* rating ($p=.20$) the *interface type* had a near significant effect on the *distraction* rating. It is unclear why this relationship between distraction and interface type exists but it does suggest that a mobile learning application interface should possibly be tested under a state of high cognitive load in order to see these types of issues e.g. interface problems may not be apparent when the learner is not in a high state of cognitive load. Other univariate analysis for the effect of the interface type did not yield any significant or interesting results.

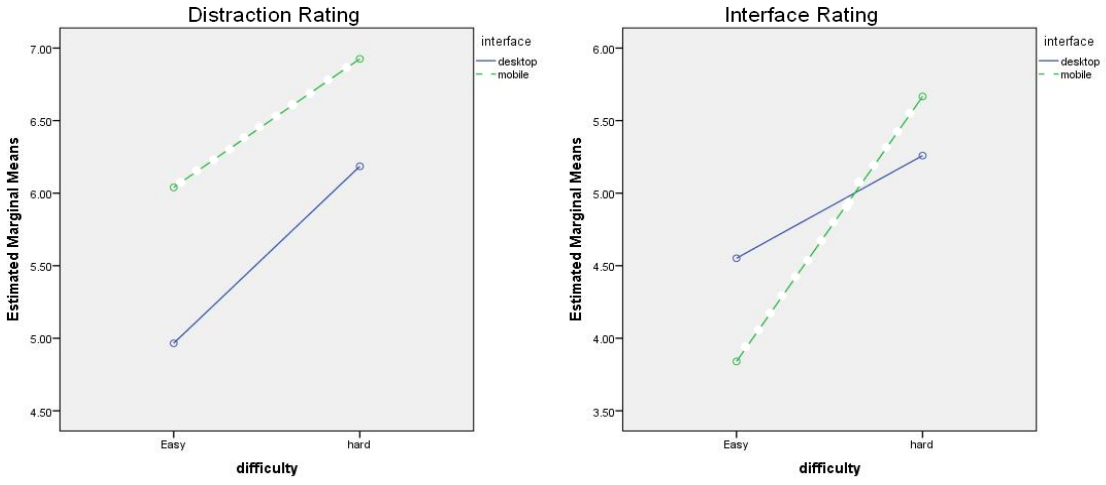

Figure 3. Distraction and interface ratings

5. CONCLUSION

This experiment demonstrated that individual ratings of cognitive load can be obtained instead of one overall level. Using this method various relationships between individual cognitive loads can be shown that would otherwise have gone unnoticed. In Cognitive Load Theory's search for a meaningful way to measure the relationship between individual loads this approach may be of benefit. Cognitive Load Theory is primarily concerned with the cognitive loads associated with a learning task and its instructional design but, as this research hopefully shows, cognitive load theory can be applied beyond learning itself to the application interface and distractions. And, possibly, when Cognitive Load Theory is applied in this way (to non learning elements), learning itself will benefit.

Usability and Mobile Usability can benefit from these results by understanding the capacity for the user to differentiate between various sources of cognitive load. These individual sources of cognitive load may demonstrate that that perceived usability of an artifact may in fact vary based on the cognitive load of the user. The results of this experiment show that the mental effort needed to use an artifact changes based on the cognitive load of the user, e.g. available mental resources. This is beneficial to Usability in general but it may be critical to Mobile Usability specifically as the user moves between various environments and various sources of cognitive load.

Learning is a cognitively demanding activity. This experiment measures other sources of cognitive load and demonstrates interactions between these loads. Mobile learning is concerned with 1) learning anytime, anywhere and 2) learning with the aid of mobile devices. Both of these activities inflict a great deal of cognitive load on the user, and should be considered when developing or planning mobile learning solutions.

In fact, mobile learning applications should be developed with cognition aware systems that can interpret sources of cognitive load (e.g. camera, motion, sound sensors to detect environmental distractions etc.) that affect the learner and adjust the cognitive load (difficulty) of the instructional material to suit, so as not to overload the learner. Further similar experiments could help generate a more robust model of sources of cognitive load for mobile learning and this can be used to build such a system.

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”MOBILE PHONES AND OTHER DISTURBING OBJECTS…”

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ABSTRACT

The impact of mobile learning on education is dependent not only on educational understanding but also on opinions of the public and policymakers. The debate in media reflects opinions and aims in different levels of the society. In order to enrich the view on what mobile learning has to battle in order to reach its full potentials I have studied news articles in order to capture some common conceptions of mobile phones in school settings. In the debate the mobile IT of mobile phones has been grouped with what is often referred to as “other disturbing objects”, and has been regarded as self evident not being used in class. Mobile phones have been used as anecdotic evidence for accentuating political messages from both the right and the left wing.

KEYWORDS

Mobile phones, policy, newspapers, debate, conceptions.

1. INTRODUCTION

The question of how to embrace the students own learning in a democratic way that keep it independent from, yet close to the curriculum is an ongoing discussion between progressivists and traditionalists (Säljö, Jakobsson et al. 2011). It is also an issue of process or product, actualized and relevant to approach in the light of the last years instrumental view on school in the political debate (Säljö 2010).

There is a gap between what students experience inside and outside of the classroom and between what they learn in school and what skills they need in life. “It is an increasingly accepted truth that education systems must evolve to meet the needs of the students and societies they serve, changing their mission from knowledge transmission to preparation for future learning” (Shear, Gallagher et al. 2011). This is an approach embracing the process of learning over result. Even though ICT is common in teaching in the schools, it is still an exception that students actually use ICT in education. This gap between teacher and learner as recognized users of ICT in school is yet to be bridged (Shear, Gallagher et al. 2011).

The evolution of new technologies can help learners in the process, opening up the classroom, enabling new ways of communication and cooperation (Säljö, Jakobsson et al. 2011). Mobile phones could be one these technologies. The use of them for learning; formal, informal and non-formal, is often referred to as mobile learning or m-learning.

In this paper I present and discuss some particularly relevant issues for understanding of the preconditions for m-learning in the Swedish school system. It is important to examine the interrelationships between formal and informal learning in a wider context. Considering empowerment and oppression this is particularly important (Malcolm, Hodkinson et al. 2003).

The technology making the m-learning possible is not brought into the existing context of the classroom without conflict. The matter is multilayered and can be addressed from different perspectives – educational, technological and, not least, political (Traxler 2007; Kukulska-Hulme, Sharples et al. 2009). I have focused on the intersection between the educational and political aspects. By studying news articles from the Swedish daily press I have sought to illumine how the mobile phones in the public debate have been presented and conceptualized in relation to the traditional arena of schooling – the classroom.

A newspapers article treated as a primary historical source captures and reflect the influential opinions and debate, both political and public in the past (Tosh 2000). They tell us of the ambition of politics and

reacts to the consequences of it. Since school is governed by politics, federal laws and curriculums, these are powerful factors. And as Gerber, Karlan et al. (2006) points out "[…] even a short exposure to a daily newspaper influences voting behaviour as well as some public opinions." That said, Gerber, Karlan et al. (2006) are not sure whether it is the content of articles or the political angle that matters. The articles presented from the Swedish press help us understand how the clash between the mobile phone technology and the governed traditional classroom context has been. From those results some conclusions can be drawn on the preconditions for innovative teaching through m-learning in Swedish schools.

In the Swedish school law from 2010 the Ministry of Education and Research states that: "The education shall rely upon scientific principles and proven experience" (Ubildningsdepartementet 2010). But which are the scientific principles on the innovative teaching and learning regarding mobile phones and m-learning?

2. MOBILE LEARNING

There are different ways of conceptualizing m-learning (Traxler 2007). I shall not more than briefly sketch some principles of the field. Among the different ways of addressing it some focus more on the mobility aspect than on the learner aspect of it, and some seek to develop more educational approaches (Laouris and Eteokleous 2005). Others promote it as being driven by technology or devices, some put the mobility of the learner in centre (Traxler 2009).

That it reaches outside of the formal classroom have been seen as one of the major benefits pointing to learning taking place whenever a person has to overcome a problem, making use of all available resources; teachers, affordances in the environment, technologies etc.. The context is dynamically constructed by the learner interacting with the environment (Sharples, Taylor et al. 2005; Kukulska-Hulme, Sharples et al. 2009). But the formal education and m-learning are not joining without friction. According to Sharples (2006) trying to incorporate mobile technology into the traditional classroom teaching might not be to do enough and could run into problems. Sharples identify two systems in school; one is the youth culture, impenetrable to adults and the other is the school with its curriculum and teachers, deciding the acceptable discourse. Mobile IT and the possibilities it creates with social networking and collaboration is part of the youths' system. In the classroom it clashes with the formal system. The confrontational approach is also shared by Traxler (2009) recognizing technology changing the nature of knowledge work, and m-learning are not learning that is mobile, m-learning is m-learning, something entirely new. Traxler (2009) states that maybe the formal education is especially challenged with the dynamics of society and technology.

Kukulska-Hulme (2006) and Thomas and Brown (2011) see possibilities for a new culture of learning, but mean that the new culture and the traditional formal classroom education can coexist and complement each other.

New technologies generate changes that both motivate and challenge. If the twentieth century was about creating a sense of stability, the twenty-first will be about embracing change (Thomas and Brown 2011).

Thomas and Brown (2011) also states that understanding it as if school has a structure too fixed for successful coping with new technologies, or on the contrary; that school has a structure too weak to harness new technology and media, is not enough. Solving problems on these premises can be successful in a short perspective, but does not create any possibilities for long-term fruitful development. The challenge must be to seek to combine structure and freedom in order to create something new, they say.

The technology of interest in my study is the mobile phone. A technology that has come in conflict with the formal and established opinion of what learning and school is about, the teacher's agenda and the curriculum (Sharples, Taylor et al. 2005; Traxler 2007). The mobile phone networks its user being a key to the virtual society and the new media. Without it we are almost alone, on the verge to being nobody nowhere (Bjärvall 2011). As students bring their own technology into the classroom they want to stay in control of the technology that they possess. This is also tangent to how the technology is recognized, is mobile IT only amusement or something else? How to handle this in school without loosing the benefits of m-learning is a challenge (Kukulska-Hulme, 2006).

Analysing the rhetoric surrounding the introduction of ICT in schools during mainly the 1990's Karlsohn (2009) bases his analysis on articles from the Swedish teachers' union press. As a consequence of the IT-friendly climate in the society at the time, almost no critical voices opposing IT were given any room. The

IT-companies were booming and all voices heard said that ICT was the future. With the burst of the so-called Swedish IT-bubble in the year 2000, the rhetoric got more nuanced.

Karlsohn focused on the ICT of the 1990's mainly computers: my study focuses on how mobile phones in a school context were described in the Swedish daily press. The material examined was mainly from the time after the IT-boom. Only the content of the articles were investigated, not the actual effects of the daily press on the opinion. Which conflicts could be traced in the material? How does the approach to the technology in the material meet the scientific approach to m-learning? Investigating those questions could lead to a better understanding of the difficulties of realizing m-learning.

Liedman (2011) describes the contemporary rhetoric surrounding the school in Sweden as a situation where the debate regarding the school system is primarily speaking in anecdotic evidence. Satisfying and agreeable as it can be to address problems this way, it is worrying when the anecdotic evidence characterise the political debate (Liedman 2011).

Liedman also describes how the present secretary of education Jan Björklund of the Liberal Party, build his career on criticising school. The other strong political power on politics regarding school in Sweden the Social Democratic party initially opposed Björklund but over time they, with some differences, joined with Björklund on criticising school. However the initiative is with Björklund, and every opponent must motivate his or her anomaly (Liedman 2011).

But is Liedman right? A scientific study with 166 participants at a college in the USA showed that most of them were negative to mobile phones in their college classrooms. The mobile phones were mainly seen as a device for cheating (Campbell 2006). The result should not be overestimated and needs to be discussed further not to be just a poll. Campbell does this by focusing on the special affordances of the classroom, but the empiric material is still very limited.

The classroom is an environment with a heightened sense of normative expectations making the mobile phones more problematic than in other contexts (Ling 2004). E.g. the expected silence of the setting makes disturbances more noticeable (Campbell 2006).

There are also other factors that might have effect on the opinions on topics regarding school, e.g. rumour and reputation (Liedman 2011).

3. MATERIAL AND METHOD

The Internet database Mediearkivet provides texts from Swedish newspapers. The newspapers analysed in the study were Dagens Nyheter (DN) and Aftonbladet (AB), selected on the basis of being two of the newspapers with greatest editions in Sweden, both being centred in Stockholm but covering the whole country, but also on political belonging and tendency. DN is unaffiliated liberal, and AB is unaffiliated Social Democratic. The material presented in a news article is always judged on what is suitable for official consumption, so I do not seek to recreate a course of events, only the debate it self. The material only tells us what was written, not what actually happened (Tosh 2000). The criterion of time is not a problem since the articles are primary sources, and the object of interest. So, to capture opinions and conceptions in the debate the material is suitable.

Using only two newspapers raises doubts of the investigation's relevance and the representativeness of the material. Hultén (2006) in her thesis, relying on several researchers, points to that even a fairly limited selection or samples of articles have a high representativeness.

Approaching the material critical, it could have shortages in that it might not be complete. The material was selected from two searches in the database. The first one conducted on the mentioned keywords "mobile phones" and "school" the second on the keywords "mobiles" and "school". Doubts could also be raised regarding the articles' originality, but the material is judged as authentic. Used by universities Mediearkivet is on a constant examination and several of the texts were presented with a viewable digital copy of the original.

The method was both qualitative and quantitative, what were examined were both patterns in the rhetoric and in the chronology of the debate. Searching the database resulted in 174 hits from DN and 271 from AB of which 55 articles from DN and 54 from AB were considered of relevance. These were articles reporting directly about school or learning and mobile phones.

The articles were read and analysed regarding the rhetoric and the contexts; educational, pedagogical, political or other, surrounding the mobile phone in the texts.

Keywords often occurring were sought out. Then a grading and classification into genres were done based on the nature of the texts; news articles, reportages, debate articles, political editorial articles, columns and comments and letters to the editorials all regarding mobile phones in class. Finally notice was taken on what the author of the article written.

4. A QUANTITIVE APPROACH

The material revealed some trends as shown in figure 1. When there are elections coming up in 2002 and 2006, mobile phone and school are more frequent in the newspapers.

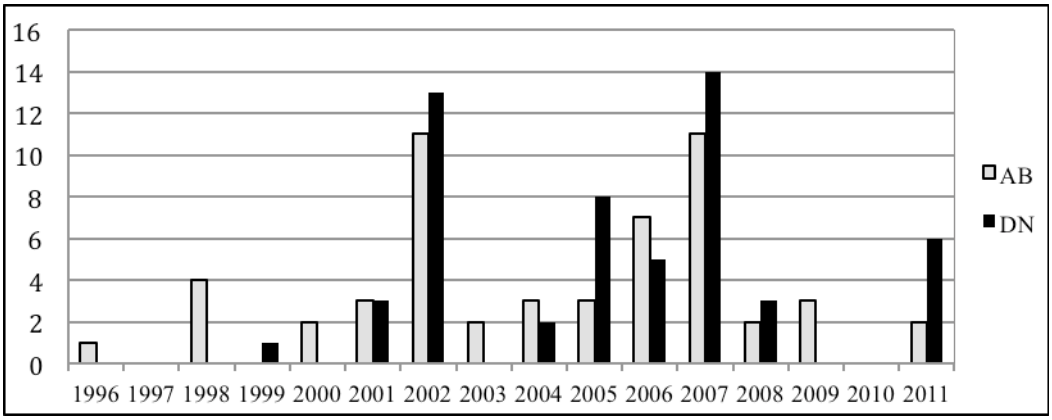

Figure 1. Number of articles published per year

The other height of articles on the topic is the year 2007. In the election in 2006 the left wing Social Democratic government was replaced by the right wing coalition "The Alliance"[1]. In 2007 the first laws the new government passed concerned school. The law gave the teachers a clearer mandate on seizure of mobile phones. Later less material from the newspapers is to be found.

5. A QUALITATIVE APPROACH

The first article of interest published by AB in May 1996 describes a school in Stockholm where pupils from first class use mobile phones as a modem to connect to the Internet when they are not in the classroom. This article is rare being early in time and positive towards mobile phones. With Karlsohns (2009) analysis in mind, this can be understood as an expression of the ICT-friendly climate in the society as a whole. But mobile phones were not that common in 1996, only 50% of the Swedish households owned one in 1996 (NORDICOM n.d.). It is not likely to believe that the children of the families, who had one mobile phone in 1996, were allowed to bring it to school. In January 1998 AB reports from a secondary school having problems with rude behaviour and bad language in the classrooms. The school has decided to ban scruff, caps and mobile phones. The connection between the problems is not further explained. From this article and on, the debate is with a few exceptions rather similar. In 1999 DN publishes an article insistent of that quarrel over mobile phones, walkmans and outer garments cannot be part of a peaceful environment for learning. Rules are needed. Björklund is given credit for having raised funds for new schoolbooks Stockholm's schools. Books create structure and must once again be part of the learning, explains the author.

In the AB articles found from 2000, one school in Norway is reported calling the mobile phone a nuisance in school, the other is reporting of the dangers of radiation. It does not address disturbance in the

[1] The Alliance (Alliansen) is the name of the political coalition consisting of the Centre party (Centern), the Cristitian Democrats (Kristdemokraterna), the Liberal Party (Folkpartiet) and the Moderate Party (Moderaterna).

classrooms, but it focus on the disadvantages of the technology, who wants their child to be exposed to radiation in school?

In 2001 85% of the Swedish households possessed a mobile phone (NORDICOM n.d.). As the development of new models evolved the old were laid of or passed on from the parents to their children (Bjärvall 2011). As the number of mobile phones increased, so did the number of articles on mobile phones in school. From 2001, the articles in AB all report on cheating by sending sms. The latest of them, strengthen the message, explaining how much better things have become since prohibiting mobile phones in a school.

The DN articles on the topic were addressing mobile phones as becoming more and more of a problem, not only with ringing but also used for gaming and cheating. But from one school another opinion is heard. A headmaster is quoted saying that a ban is the wrong way to go. The school should rather teach the students how to handle their mobile phones. That could have been an advance for realizing m-learning, but in the year of 2002 there was an election for parliament coming up.

In the debate prior to the election school and education were heavily debated. The Liberal Party was profiling itself on school questions. Their spokesmen Lars Leijonborg and Björklund plead for order and discipline in the classrooms. School was mainly described as a place where chaos rule. One of the chaos creating objects is the mobile phone. In the two months before the election there were fifteen articles portraying the mobile phones as a technology not belonging in the classrooms. Björklund was supported by Bo Lundgren of the Moderate Party saying that mobile phones were a disturbance in the work environment in schools. In DN on the 1:st of September 2002 Leijonborg in an interview say that he believe that people appreciate the Liberal Party for their plain language on *self evident* topics like not using mobile phones during class. The different actors in the debate are supporting Leijonborg's rhetorical statement of the issue being *self evident*. No other points of view were found in the pre election debate. The Social Democratic Secretary of Education Thomas Östros wrote a debate article in AB saying that, it is not *self evident* questions like mobile phones being turned of in class that determines the future of Sweden, not saying what is. Basically both political sides regard the mobile phone as a piece of disturbance grouped together with what is often spoken of as "other disturbing objects". Those objects vary, but a package of disturbance can be identified, the mobile phone is in the centre flanked with various objects of distortion, such as narcotics, sticks, videogames, fire works, knifes, mp3-players, caps, chewing gums etc..

Some keywords that can be noticed frequently occurring in the debate, for example "atmosphere of work", mainly focusing on the environment in the classroom, and how the environment is ruined by lack of order and discipline. This is endangering the keen students results. Those who do not want to study constantly disrupt those who wish to study. Mobile phones are used for ringing, gaming, filming and loud talking.

But in AB there are two articles found from the post 2002 election time that differ a bit. The Social Democrats won the election, even in Stockholm Björklund had to resign from the municipal governing. But in the whole of Sweden the Liberal Party did well, increasing their votes from 4,6% to 13,3% (Valmyndigheten n.d.) Which role the *self evident* questions played in this inconsistent result of the election is hard to say, but in the 2003 articles, both from AB, one analyses Leijonborgs success as leader of his party. The strife for a ban of mobile phones is regarded an important part of their package of political matters that concern school and therefor many people. But, no politician found in the debate was opposing the opinion. The deviant articles in AB were from November 2002 and January 2003, reporting from the same school in Stockholm. The headmaster says that mobile phones are a necessary tool in their education. The students use them for ringing when they do fieldwork. Björklund is quoted saying, that one may use mobile phones in the teaching but during class they shall be turned of. The two articles are though exceptions. In the bigger picture, mobile phones are not seen as a technology that could be of use in a pedagogical context. Rather the voices in the debate race on how to be most against them. Even the news articles have a clearly negative angel to them.

As the technology evolves there are new problems reflected in the debate. As the devices' functions evolve new problems are portrayed. At the start of the examined period the problems are not described at all and later it is the ringing and sending of sms that is disturbing. In 2004 problems with pictures taken with the mobile phones' cameras is reported of. AB is reporting on the dangers of radiation on children, and in an article DN Secretary of School, Social Democratic Ibrahim Baylan is quoted saying it is self evident that the teachers must confiscate disturbing objects like mobile phones. Sten Tolgfors of the Moderate Party is quoted saying that it is important to have a school that drives towards knowledge rather than process.

In 2005 new technologies occur again and there were eight articles from DN and three from AB. Reports of disturbing mp3 players arise in the material. In AB in February 2005 the chairman of Lärarförbundet Eva-Lis Preisz is quoted saying that the mobile phone has become a symbolic question of importance. Four students are also interviewed, being negative to a proposal on banning mobile phones and other beeping devices. They are afraid that the teachers will not conduct the assessment of what is disturbing in a fair manner. An AB editorial in July stakes that banning the mobile phones is not a dangerous proposal. What is dangerous is that it is that question dominating the debate.

From the election year of 2006 the question is not as frequently debated as in 2002. Most articles are critical towards mobile phones, but opinions are heard saying that mobile phones might not be the biggest issue with school, teachers can already handle the problems they cause and that the debate is mislead.

But mobile phones are yet, a symbolic question. One article published in AB in September is interesting in that matter. The article is about a man who has been severely beaten up by a group of youngsters. Hospitalized and injured for life his solution to get rid of this kind of violent assaults is; more discipline in school. Ban caps, mobile phones and Mp3-players!

2007 was a rather hectic year in the debate, and most articles are against mobile phones in class. Opposing the Björklund policy pupils in a primary-middle school is reported to want to allow mobile phones and mp3-players. One pupil also wants the school to get a swimming pool. They are being ridiculed.

In two articles in April 2007 the Social Democratic Party leader Mona Sahlin criticise the Liberal Party and their struggle on mobile phones in school as them being stuck with questions of the little. The schools' problem is more, she says, than whether mobile phones should be banned or not.

On June the second AB reports of the new law, giving teachers the right to confiscate disturbing objects in the classroom, objects such as mobile phones and fireworks. Most articles this year are published before 1:st of July when the law went into effect. There is also a small change in the theme of the articles. With the new law coming up most articles is about the chaotic schools and disturbance of the mobile phones. After the bill was passed, the focus shift to successful school environments, where the mobile phones have been banned in local regulations since long time. Other articles also further expresses that banning mobile phones might not be the solution to a bigger problem.

Under the period from 2007 to the fall of 2011 a small but noticeable change in the pattern of the debate occur, after 2007 when the law giving the teachers a clearer mandate to confiscate the mobile phones, the debate cools of. From 2008 there are only five articles in the material one describing a possible disciplinary use of the mobile phones in a school context. Parents could get a sms from the school when their child is skipping class.

The articles from DN is mainly similar to before but in February a reportage from a school reports of pupils being allowed to use their mobile phones for calculating and listening to music if it does not disrupt the order in the classroom.

From the year 2009 there are three articles and in December 2009 a change in the debate can be noticed. It is reported that Member of Parliament for the Moderate Party Oskar Öholm, say that since mobile phones are a part of our society they should be used in school too. On the other hand the other articles from this year are one on brain tumours caused by radiation and one on the success of the mobile phone confiscating law generating peace and a good environment in school. From 2010 there were no articles.

In January 2011, in a debate article Erik Bengtzboe of the Moderate Party's youth argues that the debate should not be about seizure mobile phones, but rather how to learn from them and what to learn from them. The school must be better in using the modern technologies. But the debate on mobile phones is not over. In the last article in the material from November 2011 the Minister of Health and Social Affairs and leader of the right wing party the Christian Democrats Göran Hägglund had an article of debate published in DN in which he called for more authoritarian teachers seizing mobile phones in class.

6. CONCLUSION AND DISCUSSION

Drawn up on the material presented above the conclusion could be that the conceptions that effect the preconditions for m-learning in Swedish school are characterized by mistrust in the technology making it possible, but that maybe the tide is turning.

The pattern visible from the material is in short that overall the reports on mobile phones in school have been on the negative effects. The technology is regarded as an object of disturbance. Rather than bridging the gap between school and the students' life, it opens up the classroom to nuisances. The technology has been used for politicians' purposes, evident both from the dates of the published material, the stakeholders and their opinions. After the law is passed clarifying allowance for teachers to confiscate mobile phones from students the subject loses some of its attraction for politicians. The debate is more nuanced and the number of articles opposing the technology being in school is not as overwhelming as earlier.

What the debate and the different voices heard can tell us is really that mobile phones in school are a controversial question. The problem of integrating the technology into the traditional classroom context is not solved with ease. There is a clash.

In the Swedish political debate concerning school the mobile phone has been well used as an argument. Even though the department of education and the Swedish School law passed by Björklund, is clear on that the education shall rely on scientific principles, the material and the debate have been focused on banning the mobile phones in school. But the law is complex to understand. It also states that education shall rely on proven experience. How is this to be interpreted?

Banning the mobile phones was one of the Liberal Party main questions in 2002. The Social Democrats did not oppose it, attacking Björklund without any ideas of an own policy on the topic. The technology is as a journalist in DN in August 2002 states, used to score votes in the coming election. Mobile phones not being in the classroom are by most opinions regarded self evident. Björklund is, as Liedman (2011) writes, the conductor of the debate. Prior to the elections of 2006 and 2010 it is not as much focus on mobile phones.

In the articles where the politicians are either writing the text or being the subject of the texts, they are describing a school where the mobile phone is the main problem. Interviewing teachers other problems surface. Teachers are not calling for a ban of the mobile phones, but not for a use of it either. Mobile phones is not the big issue, pupils know that they should turn it of. This is worth noticing since those who have the proven experience expressed in the school law must be the teachers.

What differs between the pundits in the beginning of the debate is that the Social Democrats want further investigation done by the National board of education (Skolverket). Björklund on the other hand say that it typically for them to investigate; now it is time for action. After the election 2006 there is a shift of government. The Liberal Party pass their law giving teachers a clearer mandate to confiscate mobile phones, reflected in the newspapers by an increasing number of articles on the topic during 2007. Confiscating disturbing objects has probably been allowed all the time, but based on the articles the rules have not been clear enough.

Even though they could not see what affordances the mobile technology would bring, what most of the other spokesmen in the debate miss, contradict those urging for a focus on result over process, might be the coming of a new culture of learning, where students are connected and learn together and from each other in various networks, communities and collectives (Brown & Thomas, 2011). Mobile phones might not be a question of the little, but something huge being the doors to a virtual room.

The publishing dates of the articles, both at the height in election years 2002 and 2006, indicate that the technology mobile phone was used as a rhetorical instrument for political purposes. It can be regarded as an anecdotic evidence, since many voices are being heard in material that witness on the disturbance of mobile phones ringing, in the classroom, in cinemas etc. lacked connection to education. Consequently the message carried out does not, as the school law demand, rely upon scientific principles or the complex proven experience. This is a Paradox, since the Alliance and Björklund are responsible for the school law.

It is not until 2009 that some politicians heard in the debate say that mobile phones can be of use in school. Even though the politicians or pundits do not mention it, the debate on mobile phones in the material have been behaviouristic seeking to eliminate technology regarded as creating disturbing behaviour in class. With the technology gone, disrupting behaviour will cease and the results rise. Disciplining the students with rules, restricting them from using new technology, is regarded doing this.

Obviously the ideas and consequences of m-learning is not corresponding with the political idea of what school is about. There has been a clash.

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ROLE OF PASSIVE CAPTURING IN A UBIQUITOUS LEARNING ENVIRONMENT

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ABSTRACT

Ubiquitous Learning Log (ULL) is defined as a digital record of what you have learned in the daily life using ubiquitous technologies. This paper focuses on how to capture learning experiences in our daily life for vocabulary learning. In our previous works, we developed a system named SCROLL (System for Capturing and Reminding Of Learning Log) in order to log, organize, recall and evaluate the learning log. However up to now, we just use an active mode to record logs. This means that a learner must take a capture of learned contents consciously and most of learning chances be lost unconsciously. This paper proposes a system named PACALL (Passive Capture for Learning Log) in order to have a passive capture using SenseCam to solve this problem. With the help of SenseCam, learner's activity can be captured as a series of images. With the help of this system, a learner can find the important images by analyzing sensor data and images processing technology.

KEYWORDS

Life log, learning log, passive capture, SenseCam, ubiquitous learning.

1. INTRODUCTION

CSUL (Computer Supported Ubiquitous Learning) or context-aware ubiquitous learning (u-Learning) is defined as a technology enhanced learning environment supported by ubiquitous computing such as mobile devices, RFID tags, and wireless sensor networks (Ogata et al, 2004). CSUL augments learning in the real world by presenting information on personal mobile devices through the Internet and surrounding environment like physical objects and sensors. Those CSUL applications are intended to be used all the time. This is one of the advantages CSUL called permanency. It means that learners never lose their work unless it is purposefully deleted and all the learning processes are recorded continuously every day. However, little attention has been paid to this aspect despite much attention being paid to other features such as accessibility, immediacy and interactivity to the Internet, physical environment and other learners.

The fundamental issues of CSUL are:

(1) How to record and share learning experiences that happen at anytime and anyplace.

(2) How to retrieve and reuse them in future learning.

To tackle those issues, LORAMS (Linking of RFID and Movie System) (Ogata et al. 2007) was proposed. There are two kinds of users in this system. One is a provider who records his/her experiences into videos. The other is a user who has some problems and is able to retrieve the videos. The system automatically links between physical objects and the corresponding objects in a video and allows sharing them among users. By scanning RFID tags, LORAMS shows the user the video segments that include the scanned objects. Although this system is useful in certain environments, it is not easy to be applied in practice at any place at the moment. Therefore, we started more practical research called "ubiquitous learning log (ULL)" project in order to store intentionally what we have learned as ubiquitous learning log objects (ULLOs) and consequently reuse them.

We defined ubiquitous learning log (ULLO) as a digital record of what a learner has learned in the daily life using ubiquitous technologies and proposed a model called LORE to show the learning processes in the perspective of the learner's activity. In this paper, we propose a system SCROLL (System for Capturing and Reminding Of Learning Log) that helps learners log their learning experiences with photos, audios, videos, location, QR-code, RFID tag and sensor data and share ULLOs with others. Also, learner can receive

personalized quizzes and answers for their question (Ogata, et al., 2010). This system is implemented both on web and android smartphone platforms. With the help of built-in GPS and camera on smartphone, learners can navigate and be aware of past ULLOs by augmented reality view.

2. LIFE-LOG

Life-log is a notion that can be traced back at least 60 years (Bush, 1945). The idea is to capture everything that ever happened to us, to record every event we have experienced and to save every bit of information we have ever touched. For example, SenseCam (Hodges et al., 2006) is a sensor augmented wearable stills camera; it is proposed to capture a log of the wearer's day by recording a series of images and capturing a log of sensor data. This is a great tool for recording life log. is a small digital camera that is combined with a number of sensors to help to capture a series of images of the wearer's whole daily life at the proper time and it can be worn around the neck (Figure 1). Originally this device is designed for memory aid. MyLifeBits (Gemmell, Bell, & Lueder, 2006) stores scanned material (e.g.: articles, books) as well as digital data (e.g.: emails, web pages, phone calls, and digital photos taken by SenseCam). Ubiquitous Memory system (Kawamura, Fukuhara, Takeda, Kono, & Kidode, 2007) is a life-log system using a video and RFID tags. Also, Evernote (www.evernote.com) is a tool to save ideas using mobile devices such as Android and iPhone. The most common idea of those projects is to use life-log data for memory aid. SCROLL, however, aims to utilize life-log data for the learning process.

Figure 1. SenseCam

3. SCROLL: UBIQUITOUS LEARNING LOG SYSTEM

3.1 Design

Learning Log was originally designed for children as a personalized learning resource (Ogata et al. 2010a). It was set by teachers to help their students record their thinking and learning. In this learning log, the logs were usually visually written notes of learning journals. How are we learning from past learning log? For example, we take notes, e.g., vocabularies, idioms, sentences in a language learning situation. Whereas, they will not remind us of the knowledge learned, nor the situation where the knowledge was used. We think this process can be enhanced using mobile devices. We proposed learning processes in the perspective of the learner's activity model called LORE (Log-Organize-Recall-Evaluate).

(1) Log what the learner has learned: When the learner faces a problem in the daily life, s/he may learn some knowledge by her/himself, or ask others for a help in terms of questions. The system records what s/he learned during this process as a ULLO.

(2) Organize ULL: When the learner tries to add a ULLO, the system compares it with other ULLOs, categorizes it and shows the similar ULLOs if exist. By matching similar objects, the knowledge structure can be regulated and organized.

(3) Recall ULL: The learner may forget what s/he has learned before. Rehearsal and practice in the same context or others in idle moments can help the learner to recall past ULLOs and to shift them from short-term memory to long-term one. Therefore, the system assigns some quizzes and reminds the learner of her/his past ULLOs.

(4) Evaluate: It is important to recognize what and how the learner has learned by analyzing the past ULL, so that the learner can improve what and how to learn in future. Therefore, the system refines and adapts the organization of the ULLOs based on the learner's evaluation and reflection.

Since 2009, we started our project and developed a system named SCROLL (System for Capturing and Reminding Of Learning Log) (Ogata et al. 2010a, 2010b) that helps learners collect their learning experiences as ubiquitous learning objects (ULLOs). Also, all of the collected ULLOs are organized, shared in this system, and the learning effect can be enhanced.

3.2 Learning Types

We designed SCROLL as a model of system to implement to implement the following types of learning:

(1) Self-directed and personalized learning

The first one is self-directed and personalized learning. We design SCROLL based on these two objectives that adopt self-directed and personalization:

(a) By being aware of a learner's current context, especially the location information, the system can detect whether a learner is near to the place where he uploaded a learning log and whether there are location-based learning logs recorded by other learners close to him. If either requirement is met and the availability of the device is high, the system will show him a quiz based on the knowledge he gained around there or notify him the surrounding learning logs added by others.

(b) The system can record the context data when a learner uses the system to study as his context history and then catches his learning habits by making use of the context history. If the learning habits exist and the circumstance meets the learning habits, the system will show a piece of recommendation message to encourage him to review what he has learned.

(2) Reflective learning

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. 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. 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 yes/no quiz, text multiple-choice quiz and image multiple-choice quiz. Usually, learners can examine themselves by practicing the quizzes. But two more ways that are provoked by the system are provided. One is that when a learner moves to the place where he took down knowledge, the system can show quizzes about the learned knowledge for him. The other one is that if a learner has his learning habits, the system will prompt him to review what he learned in quizzes. In the rest part of this paper, we will talk about them in detail.

(3)Collaborative learning

We design SCROLL also as a collaborative learning. Learning log is a log that a learner has done, therefore for collaborative learning in SCROLL is asynchronous model. Any learner in this system is able to share ULLOs, and system will show the shared ULLOs to others. Besides, they can also ask for others questions when they share ULLOs. In reflective learning, shared ULLOs can also be used to generate quizzes in order to help learners learn more objects.

(4)Situated learning and experiential learning

We design a concept called task in SCROLL to implements the situated learning and experiential learning. Tasks are referred as the activities that the knowledge can be used. They are related to the learning contexts like school, hospital, post office and so on. For instance, if the system recommends a learner a Japanese word "トマト(tomato)" in a supermarket, the learner can talk with the staffs in the supermarket using the word "トマト (tomato)", such as asking its price, location, recipe and so on. And it has been proved that by talking with the Japanese native speaker using the recommended word, learner can master the word well. The activity of asking about the information is a kind of the so-called task. Basically, the learners who saved the learning log are responsible for providing what kinds of tasks the knowledge can be utilized. And one learning log can be used in several tasks. Moreover, the system provides some predefined tasks in different

contexts in order to reduce the learners' burden of designating tasks when they save their learning logs. Table 1 shows part of the predefined tasks in different contexts. What's more, the tasks can be defined by the learner and designated by the administrator of the system. The system assigns the appropriate task for a learner based on the difficulty of the task and the learner's ability. For example, asking the price of the production is easy for learners to finish while asking about the recipe of the vegetables is quite difficult for most learners. And when the learners received the recommended the learning log and the task, they are also asked to provide feedback for the system. For example, they are asked to take the photos of the object if they are asked to inquire the location of it. And if they are asked to learn about the place of the production, they need to accomplish this information on the system. Only providing the feedback can prove that they have really used the knowledge. And if the learner meets new problems when he carries out the tasks, he can record them in photos, videos, audios or texts and upload them to the system in order to ask for help. Such accumulated data is also meaningful for the other learners.

(5) Seamless learning

We design the following Seamless Mobile-Assisted Language Learning Support System (hereafter we call it SMALL System) as a sub-project. It contains following parts:

(1) Textbook Data: consists of the whole units of the textbook to be learned through one semester. A teacher uploads PDF file textbook data to the system in advance.

(2) Learning Log System: or SCROLL is a system developed by our team. Users register what they have learned, which we call "learning log objects (LLO) to the system and view LLOs uploaded by themselves and others, then it supports recalling of their learning logs by giving them quizzes.

(3) Quiz: The students register textbook target words and their newly acquired words during their self-learning and the system gives them quizzes. It generates quizzes based on the LLOs registered and viewed by the students.

(4) Message: Users can send messages to other users in this system. When a viewer clicks the author name of the LLO, new window will be popped up and can send a message to him. This function will promote the students interaction or discussion and will lead to collaborative learning which will be inevitable where the teacher in not there outside-class self-learning.

3.3 Interface

SCROLL is a client-server application, which runs on different platforms including Android mobile phones, PC and general mobile phones. It contains the following components:

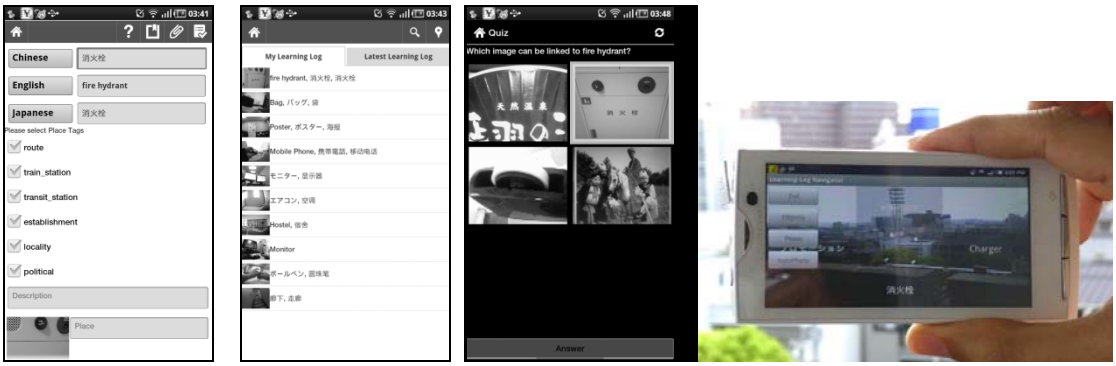
(1) ULL recorder: This component facilitates the way for the learners to upload their ULLOs to the server whenever and wherever they learn. Learners can take its photo, video and/or voice and ask questions about it and attach different kinds of meta-data with it, such as its meanings in different languages, comments, tags and location information. Also the learner can enter its barcode and/or RFID and select whether the new ULLO can be shared or not. Figure 2(1) is the interface of registering a new learning log that runs on Android smartphone. Figure 2(2) is an example of learning log.

(2) ULL finder: If learner registers a new ULLO, the system checks whether the same object has been already stored or not by comparing the name fields of each object using a thesaurus dictionary. Also, the learner can search ULLOs by name, location, text tag and time. Using this function, learners can understand what, where and when they learned before. In the future works, the visualization of the ULLOs will be developed.

(3) ULL reminder: This function is used to implement the Recall ULL in LORE model. This system provides a personalized and context-aware quiz to remind learners of past ULLOs. Quizzes are generated by system automatically from the ULLOs registered by all learners. The quiz function is designed not only to help the learners to practice what they have learned, but also to recommend what the other learners have learned and to remind them to re-learn their past knowledge according to their current location and their preferred time. Figure 2(3) is the interface of quiz function on Android.

(4) ULL navigator: It provides mobile augmented reality that allows the learners to navigate through the ULLOs. Like Wikitude and Sekai-Camera, it provides them with a live direct view of the physical real-world environment augmented by a real time contextual awareness of the surrounding objects. While a learner is moving with his mobile phone, the system shows an alert on the phone as soon as he enters the region of ULLOs according to the GPS data. This view is augmented, associated with a visual compass, and

overlapped by the nearest objects in the four cardinal directions (Figure 2(4)). It also provides him with a list of all surrounding objects. When he selects one or more of these objects, the Google map will be retrieved, and marked with his current location and the selected object. Moreover, the system shows a path (route) for him to reach to its locations. This assists him to acquire new knowledge by discovering the existed ULLOs and to recall his own ULLOs.



(1) ULL registration (2) ULL list (3) ULL Quiz (4) ULL navigator

Figure 2. SCROLL on Android.

4. PCALL

4.1 Design

Until now all works that we have done are using active logging mode, not passive logging mode. It means that learners must record their learning experiences as learning material consciously. Comparing to the passive mode, in the active mode we are more likely to miss learning chances since we are not necessarily able to record what we have learned or sometimes we just forget to record it. Therefore, we planned to introduce passive capture in our project with SenseCam and named the proposed system as PACALL (PAssive Capture for Learning Log). For example in the real world, there are so many things that we have learned but we usually miss the change to review them that is we do not know what we know. Similarity, it is certain that we are not able to know what we have not noticed. Therefore, we considered over this learning process.

Since this research is based on our previous works that use active mode to register ULLOs, we have to find out differences between active mode and passive mode in this research. We have compared both on features as Table 1 shows.

Table 1. Comparison between active mode and passive mode

	Passive	Active
Number of photos a day	Many (~3000/day)	Few (<10/day)
Quality	Low	High
Pros	Avoid to forget taking photos	Learning actively (intentional learning)
Cons	Difficult to find good photos from many photos	Forget taking photos

Figure 3 explains this process and shows how to support learning in passive mode. We classify all the objects surrounding us into 4 groups – there are “(I) I know what I know”, “(II) I know what I don’t know”, “(III) I don’t know what I know” and “(IV) I don’t know what I don’t know”. For example, for non-English speaker, when a learner walk outside and see a fire hydrant, if he notice it and remember how to speak it English that is the status (I). If he does not know how to speak it in English and that is status (II). Since he have notice it, and does not know how to speak it, he can learn it by dictionary or ask for someone else. Then this knowledge will be transferred from (II) to (I). This is the process C – learning. It only happens consciously that is to say active mode.

Another situation, if he has not noticed the fire hydrant how can he learn it? The answer is no way without any assist method. Therefore, we want to use life-log as a passive way to support it. There are also two situations. First is he have already known how to speak it in English (status III). In this case, captured life-log photos can help him notice this fire hydrant and let me revise it. In another case (IV), captured life-log photos let him know there is an object that he does not know, and then he can have a chance to learn this object (B to C). This is a good way to help a learner know what he/she does not know if he/she does not know what he/she does not know.

Figure 3 is the flow of PACALL in analyzing captured photos. There are 5 steps:

1. Loading raw data.
2. Filtering bad photos.
3. Finding good photos.
4. Photo recommendation.
5. Learning Analytics

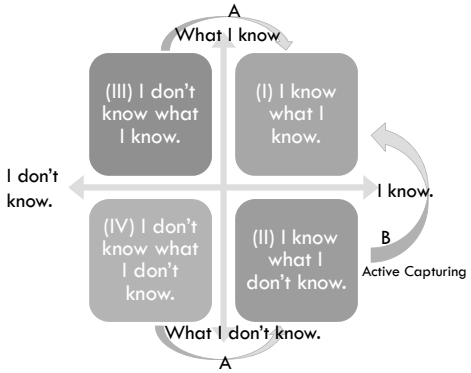


Figure 3. Knowledge transition.

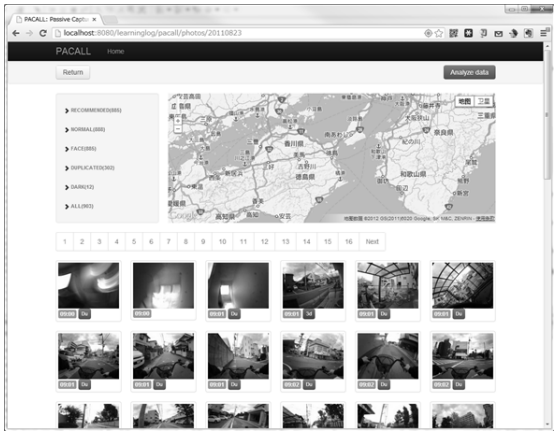


Figure 4. Interface of PACALL.

There are four steps in PACALL.

(1) Loading raw data

There are 3 types of raw data in PACALL: life – log photos, Sensor data, and GPS data. Life-log photos are captured by SenseCam at the present. In the future, we plan to apply this system to common photos. That will be interesting and useful. Imaging that you have tour and took many photos, and then you can use this system to find out learning content. Sensor data is record by SenseCam and GPS data is created by portable GPS unit.

(2) Filtering bad photos

Before filtering bad photos, we must define the bad photo and good photo. In this research, we define that bad photo is a photo that is hardly to recognize its content or that is duplicated with other photos, while good photo is a photo that contains clear objects. We define three types of bad photos:

(a) Dark: Dark means a photo taken with insufficient light and the photo is dark.

(b) Duplicate: Duplicate means the photos are duplicated.

We use image processing to find out these bad photos. Currently, we are using OpenCV to detect photos dark, and using LIRE(a plugin for Lucene) to detect duplicated photos.

(3) Finding good photos

As it is defined in (2), the good photo is clear photo and contains clear objects. Therefore, we are using OpenCV to find out good photos mainly by feature detection. After finding out good photos, left photos are common ones. Those photos are not so clear but maybe contain learning contents. However the priority of those photos is lower than good photos when shown to learner to choose.

(4) Photo recommendation

Until now, bad photos are filtered out and system selected several good photos for learner. Photo preparation is finished, and it steps into the stage of learning content assistant. We attempt to abstract useful information from photos by machine, and recommend photos that contain information. Therefore we define 4 types of recommended photos:

(a) Character photo: Character photo means a photo that contains characters. These characters are probable used as learning content. Here we are using text detection to find these photos.

(b) Face photo: It is certain that face photo means a photo that contains faces. Actually, these photos are usually not appropriate for learning content because of privacy issues. Anyway, faces are also information from photos.

(c) Taggable photo: Taggable photo means a photo that can be tagged by text. Tag is important information of the photo and it is probably used as title of photo.

(d) ULLO-like photo: If there is a similar photo that was already registered to the SCROLL as a ULLO, maybe this photo is also can be used as a ULLO.

4.2 System Interface

In the section 4.1, we introduced our research design especially design of the flow of analyzing photos. We developed functionalities in detail.

(1) PACALL Uploader

PACALL Uploader helps learner upload all the photos after capturing. We want to make it easy to upload all the captured photos to the server. Because of the limitation of web technology, this process is not so easy in the past. However with HTML5, it becomes possible. When a learner wants to upload the whole folder, learner can select a photo folder and upload all the photos to the server. Also, the file of sensor data and GPS data will also be uploaded.

(2) PACALL Browser

After uploading the raw data (photos, sensor data and GPS data), system will analyze all the data and show the result for learner When all the photos are uploaded to the server, the learner can have a reflection of all the photos with the help of PACALL. PACALL Browser is an interface of browsing all the photos, and it tags photos and provides some information of photos to help learner find important photos (Figure 4). Currently, we provide three main functionalities in PACALL Browser – PACALL Filter, PACALL Searcher and PACALL Recognizer. PACALL Filter classifies all the photos into categories such as Manual, Normal, Duplicate, Dark, Face and Recommendation. Here manual means that photo is captured by pressing manual button of SenseCam. It usually happened when learner finds something valuable to record. Duplicate and Dark contains bad photo. Face means the photos contains faces and Recommendation includes Manual, Faces and other good photos that contains information or have similar photos that have been uploaded to SCROLL before. Such photos have tag under the photo like 3d or 4d means there are photos uploaded to system 3 or 4 days ago.

(3) PACALL Recaller

When a learner clicks one photo in PACALL browser, the PACALL recaller will be opened. The photo and the similar photos and sensor data will be shown on this page to help user recall the captured content. There is also a “Upload” button on this page. If the learner decide to upload this photo to SCROLL as a ULLO, s/he can clicks this button, the photo will be uploaded to the SCROLL system directly and the page will jump to the learning log registration page (Figure 4). Figure 4 is the interface of ULLO registration in SCROLL system. On this page, a learner can see the location of the selected photo and other similar photos that captured by SenseCam. If there are some similar photos that are already existed in SCROLL, the similar photos will be also shown on this page. Once “Upload Now” is clicked, the system will ask student to answer a survey that let system know whether learner know it and noticed this object when it was captured. The data can be used to evaluate our system and help learners analyze the learning situations. When an object is uploaded to the system, SCROLL system will use “organize”, “recall” and “evaluate” model to help learner remember uploaded objects and vocabularies. For example, if a learner uploaded a photo and set the title as “消火栓” in Japanese, but s/he does not know how to speak it in English, then s/he can send a question along with the uploaded ULLO. SCROLL will send this question to all Chinese users. After receiving the answer from Chinese users, this learner learned a new Chinese word. In the quiz module of SCROLL, learner can answer the quizzes that are generated by uploaded ULLOs. By answering these quizzes, learner’s knowledge will be enhanced.

5. CONCLUSION

In this paper, we discussed how we can learn vocabulary from the life-log pictures. In order to do it, we used SenseCam to capture life-log passively and developed a system named PACALL to help learner to register learning log objects with vocabulary. We have designed a model of learning process in passive capture mode including capture, reflect, store. The PACALL system has been also developed in order to support reflection and reduce the workload of reviewing photos. During this research, we found that the SenseCam that originally designed for memory aid can be also used to capture learning log for passive mode to help learners to learn vocabulary. However, it usually takes too many photos, and many of them are duplicated or dark. Therefore, we must introduce other technology to help learners find out important photos. Currently, we are using sensor data to help us do it. In the future, we also use images processing technology to detect the contents of photos. Besides, current algorithm and user interface also need improvement. In addition, we plan to conduct a full evaluation experiment and invite more students to use this system in the near future.

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ANDROID BASED MOBILE ENVIRONMENT FOR MOODLE USERS

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ABSTRACT

This paper is about the development of a platform that eases, throughout Android based mobile devices, mobility of users of virtual courses at Technological University of Panama. The platform deploys computational techniques such as "web services," design patterns, ontologies and mobile technologies to allow mobile devices communicate with Moodle CMS. This creates a collaborative and customized environment of interaction and alerts that allows an efficient, flexible, and transparent communication. The environment is based on service oriented client server architecture, achieved through the Service Oriented Architecture (SOA) methodology that eases reuse. The client will have alerts, file downloads, forums and chats, grading, quizzes, and calendar, among other functionalities.

KEYWORDS

Mobile devices, Android, Moodle, mobile learning, Service Oriented Architecture.

1. INTRODUCTION

Nowadays, many mobile devices can be used in the learning process such as smartphones, tablets and multimedia players. Among these, smartphones are the most promising given its large target audience all over the world, no matter age or economic background of users. Another important factor is the huge computational power of these devices which in many cases over reach processing and storage capabilities of desktop computers of some years ago. On top of that, it is possible to use software that has been adapted for them, such as text editors and PDF readers, originally designed for desktop computers. Integrating mobile devices into education aims development of networks that include new working and collaborative learning methodologies.

Data networks foster resourceful communication environments that allow the exchange of experiences from students in the same site and from diverse geographical contexts. Many countries have developed Wi-Fi networks along complete cities which facilitates combining learning environments with the mobility that comes from such devices. This combination of educational environments with the mobility from smartphones, tablets, multimedia players and this kind of devices to build mobile learning strengthen and increase cooperation and interaction among users. This way, mobile Internet allows creating means for accessing resources everywhere and any time.

Moodle is a Course Management System (CMS) that allows professors create online learning scenarios. According to (Felizardo et al., 2007), the main strengths Moodle has are its communication tools, creation and management of learning objects. Whereas Moodle as well as other educational platforms count on these advantages, they don´t provide a collaborative environment of interactions and alerts for Android based mobile devices.

Under this perspective, this paper presents MLEA (Mobile Learning Environment Adapter), a mobile environment based on Android for users of virtual courses on Moodle at Technological University of Panama. MLEA facilitates integration of several educational resources that support mobile learning, throughout an innovative and modular mobile solution able to adapt to every need by deploying all communication facilities that Information and Communications Technologies (ICTs) provide nowadays. This collaborative environment is defined not only under the professors´ perspective but also of students. There will be several communication means and alerts for both (professor and student) as well as interaction ways with Moodle tools.

The decision of developing for Android operating system is based on the fact that is an Open Source architecture available in the 3G market place and given the great number of research and developers creating new features for its hardware. Android platform is based on Linux and was created specifically for mobile devices.

The next section presents some background information. It deploys the main concepts that inspired developing MLEA, including mobile learning and its characteristics. Section three is about related work, development of mobile technology and mobile learning. Section four describes MLEA architecture model from the perspective of Service Oriented Architecture (SOA) paradigm; the client which represents the application for Android mobile devices; and the server where the integration with Moodle is explained. In section 5 are presented the feature of custom alerts so users keep updated about activities related to their courses. Finally, section six is used for conclusions and future work.

2. BACKGROUND

The beginnings of the Virtual University Program of Technological University of Panama (UTP) are in 2000, when talking about virtual education or e-learning was a novelty term in this country and there was no evidence of local actions of this kind. The program started as a "shy" project aimed to using ICTs in teaching and learning processes among six departments and seven branches of UTP along the country.

According to (Clunie, 2008), in 2003, UTP, aware of its role and responsibility with Panamanian society and lined up with its vision and mission, created Virtual UTP (UTP virtual), taking advantage of hyper-technologies (Clunie, 1995), in response to the needs of specialization and continuous education of people that due to work, schedules, distance, family responsibilities and/or physical despairs did not have possibilities to attend on site education. Virtual UTP emerged as a democratizing element of higher education as well as an alternative to on site education aimed to offering equal learning opportunities for those constrained to attend school.

2.1 Motivation

As in other areas or domains of knowledge, mobile learning applications are not isolated from each other and, although many have been created for specific purposes, today it is common the integration of applications (Hansen and Crespo, 2003). Meanwhile, connecting software requires the creation of processes that integrate individual applications in a consistent and efficient manner. Today, we observe the increasing proliferation of research and work done in the area of mobile learning from simple communication, evaluation and support tools for inclusive environments, which, from a single site, become available various resources and tools to meet major needs that arise from activities of teachers and students (Hansen and Crespo, 2005). The integration provided by Internet brings a significant change in the position of users toward educational software. The problem is no longer how to produce the necessary software? Now the problem has become where to find and how to use the necessary software? Thus, to find a resource that meets their needs, the user often finds a collection of pieces of software that are incompatible and, furthermore, do not have mechanisms of integration, that is why MLEA attempts to fill this gap, identifying Moodle functionalities that can be easily used in mobile devices, taking advantage of its characteristics.

2.2 Mobile Learning

Mobile learning is defined by (Pan et al., 2010), as any type of learning that occurs when the student is not in a fixed, predetermined, place, or when the user obtains advantages of the opportunities offered by mobile technologies. In addition, mobile learning can be seen as complementary approach to traditional distance education, which gives students freedom of time and space (Georgiev et al., 2004), through the use of mobile devices like smartphones and tablets (Wains and Mahmood, 2008).

The main feature of mobile learning is the ability for students to study anywhere and anytime, in accordance with the needs of combining study with work, family and social life.

Within the mobile devices that can be used for mobile learning, cell phone emerges as the most promising. Some factors that demonstrate this condition are:

i) ubiquity: cell phones are an important part in the lives of people, those who carry them everywhere. Some data show that the number of cell phones sold in Brazil in 2010 was over 180 million, which represents a little more than 95 phones per one hundred (100) people (Anatel, 2010). In the case of Panama, the annual rate of mobile phones per 100 inhabitants, for the same year was estimated at 185.4 and 90.7% coverage of the population (ASEP, 2010);

ii) performance: the processing and storage capacity of these devices exceeds the capacity of computers of a few years earlier (Prensky, 2005);

iii) GPS: integration between cellular and satellite positioning technology provides new educational opportunities based on the location of students. For example, it is possible to recommend the formation of working groups for discussions, debates and other activities, according to their physical locations.

A very important aspect, when talking about of mobile learning, is that it does not have to be treated as a substitute to the usual paradigm of distance education provided by the computer, but as a complement, in the sense that it offers more freedom (and sometimes greater motivation) to students in their learning activities. Based on the above, the architecture developed is appropriate, given that aims at the integration of a learning platform (Moodle) with the new trend of mobile teaching-learning.

2.3 Literature Review

Several papers discuss advances of mobile technologies and the concept of m-learning as a complement of distance education. This section presents a brief description of some works that have similarities with our project.

(Colazzo, 2003) presents a course management system adapted to mobile users´ needs, using web services to define the communication interface between a CMS and mobile extensions. In (Wains and Mahmood, 2008), there is a framework for integrating a mobile learning environment with an e-learning environment, where, from SMS chat rooms, learning is fostered through forums and debates to discuss problems, thoughts and ideas; also voice calls can be made as well as radio and television transmissions. However, almost all content can be accessed through cellular phones´ Internet connections, without any customization of learning objects, which can be quite inefficient.

Technical literature also reports work related to mobile communications and distributed services. (Ibrahim and Zhao, 2009) present a conceptual model of a framework for mobile devices` communication that supports mobility and distribution of services among multiple platforms. This model is based on ubiquitous communication requirements, such as: spontaneous interoperability, mobility, and software adaptability. Many of these principles, among them client-server communication and mobile agents, are a referent to our project; but unlike ours, the proposed architecture (Ibrahim and Zhao, 2009) is designed for Java Virtual Machines (JVM).

The first formal proposal by Moodle (Module Object-Oriented Dynamic Learning Environment) has some screen shots for the development of an implementation of Moodle 2.0 on iPhone and Android. It includes eight features: uploading files, student course information view, sending and receiving messages, platform resource view and downloads, seeing or assigning grades, attendance, forum view and posts, calendar, and survey. As mentioned above, this project is still at the proposal stage, with only some screen designs (Moodle, 2011).

2.4 MLEA Architecture Model

Figure No.1 shows MLEA environment organization, from a client-server model architecture perspective. In the right side, it is shown the client which represents the application developed for mobile devices based on Android operating system; meanwhile, in the left side it is shown the server, the infrastructure that makes the link with Moodle environment.

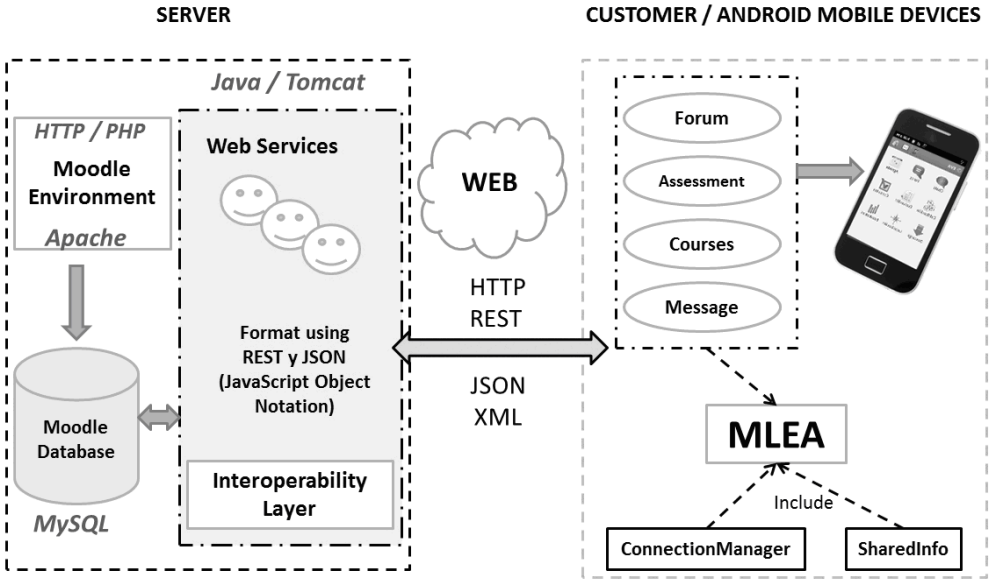

Figure 1. MLEA Architecture.

In the server side, a group of web services act as communication interface between clients and the server, which make it possible to provide clients with integrated features. A web service is a software component defined by an independent interface available through a data network. Operations defined in this interface, deploy business functions (Hewitt, 2009). Through web services clients have access to main resources on Moodle, such as forums, evaluations, messages, chats, file download, location, alerts, announcements, grading, and course, among others. At a request, a web service accesses Moodle data base to retrieve and/or manipulate the data needed to respond to that specific request. In the client side, implementation is based on Android development pattern: for each application screen, there is a Java class responsible for controlling actions of that screen.

2.4.1 Service Oriented Architecture (SOA)

MLEA is based on SOA (Service Oriented Architecture), an architecture that assists fast development of processes in complex environments and facilitates module reuse. It defines the use of services to support business requirements providing a methodology and a framework for building highly scalable information systems, at the time that offers a clear and well defined way to expose and invocate services, which as a result facilitates interaction among different systems.

2.4.2 Client

The client side, meaning, the Android application, uses Façade project pattern (Gamma et al., 1995) to make communication between screens and the class responsible for invoking web services. Each screen in this Android application holds an associated class. This way, for each functionality (i.e. forum, evaluation, courses, messages, chat…) provided there is a group of screens, therefore, a group of Java classes, represented in the architecture by the use of packets.

Figure No.2 illustrates the use of MLEA class that acts in the application like a façade to provide communication between classes and it is used by all the deployed requirements. In this image, it can be seen that the created modules (i.e. Forum, Evaluation, Course, Messages…) are clients of MLEA class, which defines an interface between ConnectionManager and SharedInfo classes, isolating them from the rest of the application. SharedInfo class manages the mobile device´s database, where user information is stored such as authentication, connected users´ ID, and chosen course, likewise cache data. This image shows only some of the modules developed. The architecture is made up of the following modules: login, forum, evaluation, messages, chat, file download, localization, alerts, grading, course selection, survey, forum evaluation, forum statistics, and view of connected users.

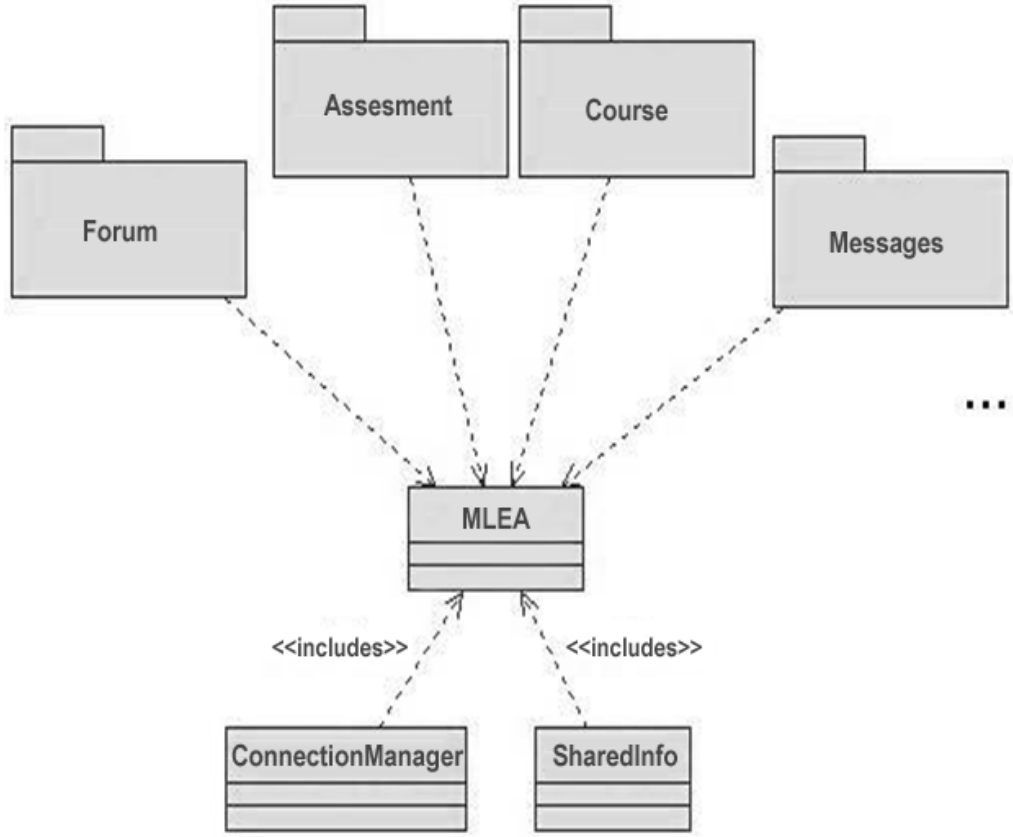

Figure 2. Client View.

2.4.3 Server

The server side relies on two design patterns to respond to client requests. First of all, web services use the project pattern DAO (Data Access Object) (Alur et al., 2003) to access and manipulate Moodle database. For each data type used there is a DAO interface that defines the operations that can be performed with it. The layer of the application model has the following data types, each with a specific DAO interface: login, forum, evaluation, messages, chat, file download, localization, alerts, grading, course selection, survey, forum evaluation, forum statistics, and view of connected users. In order to provide higher flexibility, DAO classes are not instanced directly by web services; but a factory is used to create DAO classes. This practice corresponds to the use of the project pattern FacthoryMethod, which assures the complete application uses the appropriate DAO according to a chosen setting. Figure 3 presents the use of design patterns, where a group of web services uses DaoFactory to create interfaces´ instances, which are used to access and manipulate information in Moodle database.

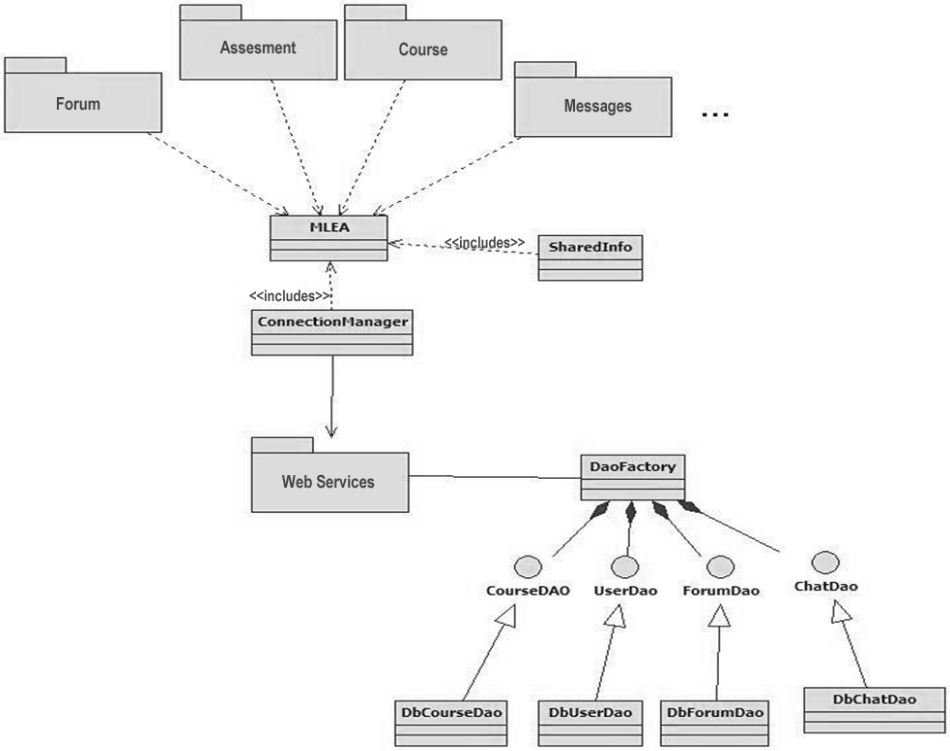

Figure 3. Server View.

2.5 Custom Notifications

An important aspect of the presented architecture is that it offers a tool to provide custom notifications for students and professors, allowing them to be updated about the activities related to their courses. Users that want to receive notifications are provided with a web interface to define, for each course, individually, every event they want alerts from. To be able to make use of this feature, users must be authenticated. Figure four presents the authentication screen, where users must enter the same information used for authentication in the Moodle environment.

Figure 4. Authentication Screen.

Figure 5 presents the configuration screen for notifications, where users define parameters to receive the notifications they want. Users, depending on their role in the course, have the possibility to customize them as professor or student.

Figure 5. Notification Configuration Screen.

i) Students: they can set notifications to know about the occurrence of the following situations: creation of new discussions in forums, any news from professor, evaluation of a student´s activity, creation of new activities (chat, quiz…), or when another student or the professor is online. Meanwhile, configuration capabilities for students can be restricted by professor.

ii) Professors: they can customize notifications for the following situations: when a student answers a question, sends information or starts a new discussion. Professor can monitor and being notified (alert) about actions taken by students. Moreover, professor can set students to be notified – mandatorily – about any important action he decides. For instance, professor can define all students to be notified whenever a new activity is created; this way, students cannot configure this alert, but keep control on other alerts they have defined previously.

3. CONCLUSION

By the use of computational and software engineering techniques such as web services, design patterns, ontologies, and mobile computing technologies, MLEA platform solves a variety of needs of users of virtual education programs. Moreover, MLEA impacts by offering an architecture that makes it possible to integrate several educational resources, which allow users, choose the most convenient for them in a given situation. Such an architecture offers a mobile learning environment that can be accessed anywhere, there is wireless connection to Internet, through smartphones, tablets, multimedia players and similar devices based on Android operating system. MLEA is based on SOA, an oriented service architecture that facilitates fast development and module reuse in complex environments as well as the creation of highly scalable systems while offering a clear and well defined exposition and invocation of services that eases interaction among different systems.

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A MOBILE PLATFORM FOR ADMINISTERING QUESTIONNAIRES AND SYNCHRONIZING THEIR ANSWERS

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ABSTRACT

This paper describes a platform for administering questionnaires on smart-phones and tablets. The project arises from the need of acquiring data for monitoring the outcomes of different homecare interventions. First a model has been defined for representing questionnaires, able to support adaptivity in the dialog with the user and enforce some simple consistency rules for checking his input. Then an application has been implemented able to run instances of those questionnaires. It downloads questionnaires over the air in terms of XML files from a server and stores them locally into a local repository. At that point questionnaires become available for the user who can select which one to fill in according to his needs and the specific treatment protocol. A questionnaire may be filled in all at once or be completed in subsequent steps over time since the input provided is persisted on a local database. Finally, when a questionnaire is closed all the answers are transparently synchronized to a server for further evaluation or statistical purposes.

KEYWORDS

Mobile Applications, Multimedia Applications, Computer-Mediated Communication, eHealth Policy and Practice, Evaluation and Assessment.

1. INTRODUCTION

Techniques for administering questionnaires are varied and evolved over time in parallel with technological progress. Early techniques involving face to face interviews or paper-based questionnaires sent by surface mail turned into telephone interviews and more recently into massive e-mails, phone calls automatically collecting answers, and web interviews. That evolution is motivated either by the possibility of reaching an increasingly larger population sample as well as by performing an improved analysis on the outcomes with a dramatic decrease in the time and costs required for setting up and processing the study [Dillman, D.A. et al., 2009].

Coming to the medical domain, the use of surveys for epidemiological studies is popular among pharmaceutical companies and organizations dealing with public health care [Valente, T.W. 2007]. Results emerging through those studies often have a great impact on starting public health care campaigns. The specific point of view of the patient is also gaining focus by the modern medical practice since it provides a deeper insight on the perception of the quality of care and also accounts for its personalization [Baker, D. et al., 2005]. To this aim questionnaires are being used in health care and social welfare contexts for assessing resource use, access to treatments, quality of services and patient satisfaction in order to improve the overall efficiency and effectiveness of the services.

A different perspective exploits surveys to assess the patients' quality of life. This provides an indirect estimation of the outcomes of medical actions in terms of treatments efficacy or the patient's own health perception and constitutes the foundation for economical (cost/utility) studies considering the costs sustained by the national services [Carr, A.J. et al, 2001]. Measuring the quality of life is also important for assessing the evolution of chronic diseases which are increasing due to population aging and changes in people lifestyle. For example, the EuroQol-5D is a popular questionnaire developed by the EuroQol Group [Rabin, R. and de Charro, F., 2001] administered to patients in many countries and in a variety of clinical areas to assess a generic measure of health status in terms of a simple descriptive profile and a single index value.

This paper describes a mobile platform available on smart-phones and tablets running the Android operating system for rendering questionnaires and collecting answers from users. The questionnaires are downloaded over the air and stored into a local library. Once in the library they become available for entering answers at user will. This means that they can be filled all at once or incrementally at different times. Answers provided by the user are checked against a model which also provides the basis for personalizing the navigation across questions: our platform allows the dynamic adaptation of questions according to previously provided answers. When the user is finished with an instance of a questionnaire, the instance is closed and all the answers are synchronized with a central repository so that they can be accessed for a subsequent analysis. The platform also supports the complete substitution of a questionnaire by downloading a new one, which is a key issue for dealing with new emerging scenarios.

The work has been motivated by the need of supporting two different scenarios related to ongoing research projects in health care at our institution. The first one is meant to improve after-discharge home assistance for *fragile* patients, specifically preterm newborns and elderly renal patients. The need to keep medical expenses under control are pushing towards home care with respect to hospital confinement for this kind of patients. A questionnaire has been designed to collect the needs of those patients and their home caregivers, as a preliminary step for the development of a tele-homecare system. The second scenario addresses the MobiGuide project funded by the European Union and dealing with support for patients guideline enforcement anywhere and anytime including at their domiciles. Patients are provided with tools helping them in adhering to the guideline related with the treatment, and are asked to periodically report information about their satisfaction with the support provided by MobiGuide as well as their clinical status and progress with the treatment. In both cases questionnaires are used as a means for reporting information to the clinic center.

2. DESIGNING THE PLATFORM

The first task to be accomplished when setting up a survey, soon after the main goal of the study is defined, deals with identifying the way in which the questionnaire is to be administered and how data should be collected, as well as with the actual design of the items building up the questionnaire. This involves preparing a clear textual definition for each question, rendering them with a proper wording and partitioning all of them into a suitable set so that they can be proposed into the most appropriate order to the user [Morrison, R.L. et al., 2010]. Structuring the questions is particularly important as the target user perceives their sequence as a virtual conversation through which the survey designer elicits his answers. In order to properly motivate the user and capture his attention, that conversation should avoid being repetitive, trivial or ambiguous. To this aim in a written questionnaire directions are helpful for making explicit the meaning of each question and the specific intent associated with their answers, although a careful tradeoff should be considered. While the absence of directions could be misleading for the user and possibly result in eliciting the wrong answers from him, an overly long set of instructions could be perceived as obtrusive and demotivate the user thus yielding the opposite result [Smyth, J.D. et al., 2006].

2.1 The Questionnaire Model

Designing a platform for rendering questionnaires implies as a prerequisite the capability of representing the questionnaire itself. Thus we developed a model with a high level of flexibility in order to better capture and shape the dialogue with the user, which is described in the following. Within the model developed, a *question* is a group of information that must be shown together to the user. Its main components are the *question text* and one or more *answers*. The former conveys the primary meaning of the question and provides a framework for the input to be supplied by the user. Answers represent instead some ancillary information acting as placeholders and shaping the context for the actual input. Thus a single answer may include multiple input items which are all considered related and should be consistently filled in.

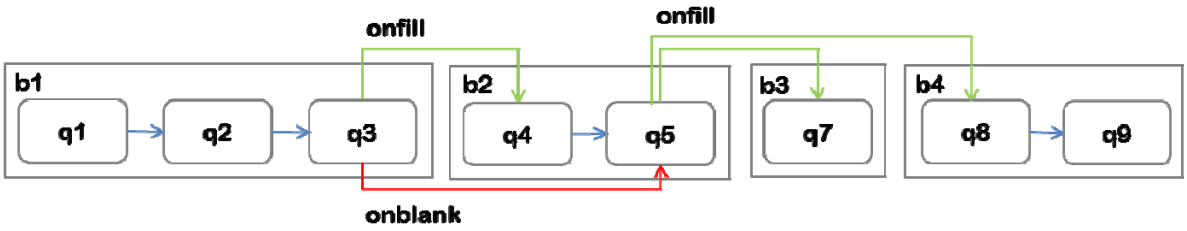


Figure1. Navigating through the questions of a questionnaire.

Following a short review concerning the question types addressed in the literature we decided to model an answer with fixed parts called *labels*, which are not user editable, serving the purpose of introducing *inputs*, where the user actually enters information. Data may be entered into an input either by typing or by selecting one of the available choices associated with it. In designing the semantics of input elements we capitalized on the Html experience allowing a broad set of types such as *text boxes*, *checkboxes*, *radio buttons* and *choice selections*. We also allow structured input types, such as the *yes-no* choice which is rendered by the application through primitive types such as buttons or multiple choices. Finally, for those answers requiring it, *answer instructions* may also be available to better specify the meaning of an answer or clarify the question context altogether in order to support the user choice.

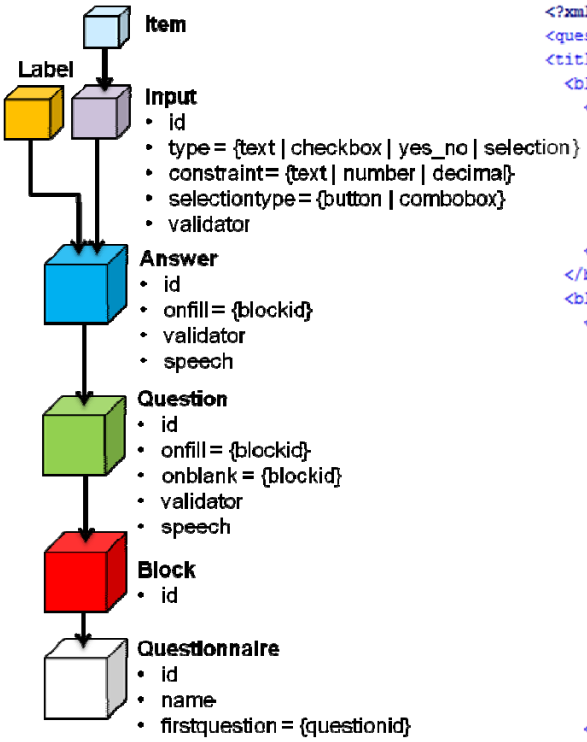
Another important requirement of the model concerns the definition of constraints for the questionnaire which help in reducing errors and checking the correctness of the input provided by the user. We adhered to a very simple constraint model for fields where input can be restricted to the available choices, and possibly be marked as mandatory. Additional constraints may also be defined at the answer or question level, for specifying the number of mandatory input or answer combinations.

In order to provide a dynamic adaptation of the questionnaire which better captures the needs of a monitoring scenario in a clinical context, the model also includes *navigation rules* for shaping the correct sequence of questions according to the previous answers provided by the user. For example, a compound question might be "did you require assistance from medic/paramedic staff during the treatment" ? If the user answers "no", no further inquiry concerning the staff is performed. However if the answer is "yes" a section is entered asking specific information detailing the assistance required. This should be repeated as many times as there are invocations of assistance issued by the user.

Navigation rules can be set up on a whole question or on specific answers, as shown in Figure 1. In fact questions are arranged into *blocks* inside which navigation proceeds sequentially unless a specific rule is established. For example in block *b1*, question *q1* is always followed by question *q2* no matter how the user replies to the answers included in question *q1*. At the question level two different rules may be defined addressing the fact that the user provided some input (i.e. *onfill*) or not (i.e. *onblank*). This is represented by the two lines departing from question *q3*, meaning that if the user provides some input to question *q3* then question *q4* is shown, if he doesn't question *q5* is accessed instead. Answers may only specify an *onfill* rule pointing to the next question to be accessed if the user provides some input to that answer. For example, the two lines departing from question *q5* and pointing to questions *q7* and *q8* represent the *onfill* rules relating to two different answers available in *q5*. If there are no navigation rules for a terminal question of a block the questionnaire is considered finished, as it happens in questions *q7* and *q9*.

The navigation rules devised make it possible to skip some questions or move to explicit ones depending on the user answers, therefore better shaping the virtual interviewing conversation with him. By properly structuring a question in terms of answers and inputs, placing constraints at the question, answer or input level, and defining suitable navigation rules a great degree of flexibility is achieved, able to capture the requirements of almost any complex questionnaire scenario. For example this accounts for excluding blocks altogether depending on previous user input or repeating some questions several times in order to collect all the user's information required for a study.

Given the description of the model proposed, XML seemed to be the most appropriate representation language for encoding a questionnaire. Figure 2 illustrates on the left all the elements referenced in the XML schema while an excerpt of a questionnaire is reported on the right. The root element is *Questionnaire* including *Block* elements which then encompass *Question* elements. Each question is composed of several 7 *Answers* including *Labels* as fixed components or *Input* elements representing placeholders for the user input.




```
<?xml version="1.0" encoding="UTF-8"?>
<questionnaire id="1" name="questionnaire" firstquestion="q1">
<title>Home context and need for assistance questionnaire</title>
  <block id="b1">
    <question id="q1" onfill="b2" onblank="b3" validator="-1"
      speech="Did you have problems with drug consumption?">
      <title>Did you have problems with drug consumption?</title>
      <answer id="a1" validator="-1">
        <input id="i1" type="checkbox" validator="-1"/>
      </answer>
    </question>
  </block>
  <block id="b2">
    <question id="q2" onfill="b5" validator="-2"
      speech="Which kind of problem?">
      <title>Which kind of problem?</title>
      <instruction>Specify at least one</instruction>
      <answer id="a2" onfill="b3" validator="-1"
        speech="Specify at least one">
        <input id="i2" type="checkbox" validator="-1"/>
        <label>Wrong dosage</label>
      </answer>
      <answer id="a3" onfill="b4" validator="-1">
        <input id="i3" type="checkbox" validator="-1"/>
        <label>Wrong preparation</label>
      </answer>
      <answer id="a4" validator="-1">
        <label>Other: </label>
        <input id="i5" type="text" validator="-1"/>
      </answer>
    </question>
```

Figure 2. The XML elements representing the questionnaire on the left and an excerpt on the right. The excerpt refers to the questionnaire for the parents of preterm newborns.

The XML section also shows some navigation rules set up for question and answers in terms of *onfill* and *onblank* attributes. Constraints are also defined through the *validator* attribute holding a code corresponding to the specific action. For example the validator code *-2* in question *q2* means that it is mandatory to fill in at least one answer, but more are allowed as well. The validator code for any answer included in question *q2* is instead *-1*, which means that their filling is optional, as it also happens for any included input item. In fact, in that case each answer only includes a single input item so the same validator is used at both input and answer level. Finally, the *instruction* element and *speech* attributes provide suggestions which may be rendered as side notes or as spoken language by the renderer.

2.2 The Functional Architecture of the Platform

The model proposed allows the definition of a questionnaire along with all the associated constraints and navigation rules. However this only helps in representing the set of questions and still leaves open the problem of collecting feedback from patients during clinical studies involving experimental protocols. Thus we needed an application able to support running instances of those questionnaires and we selected smart-phones and tablets as the target devices for the implementation. This is in line with current studies concerning clinical diaries showing that users are more comfortable with portable devices since they are available and ready to use at any time and in every place whenever they are needed [Franc, S. et al., 2011]. We also selected the Android operating system because it is open-source and available on multiple hardware.

Figure 3 shows the overall functional architecture of the platform illustrating the full workflow supported by it. That workflow starts with the *design* of a new questionnaire, which basically entails writing the XML file representing it, and *deploying* it as a module on a server repository as shown in the upper part of the figure. The mobile application notices the availability of a new questionnaire module, then *downloads* and saves it into its local module repository. A questionnaire may either supersede an old one, therefore substituting it in the application library, or be stored as a new one representing an additional choice for the user.

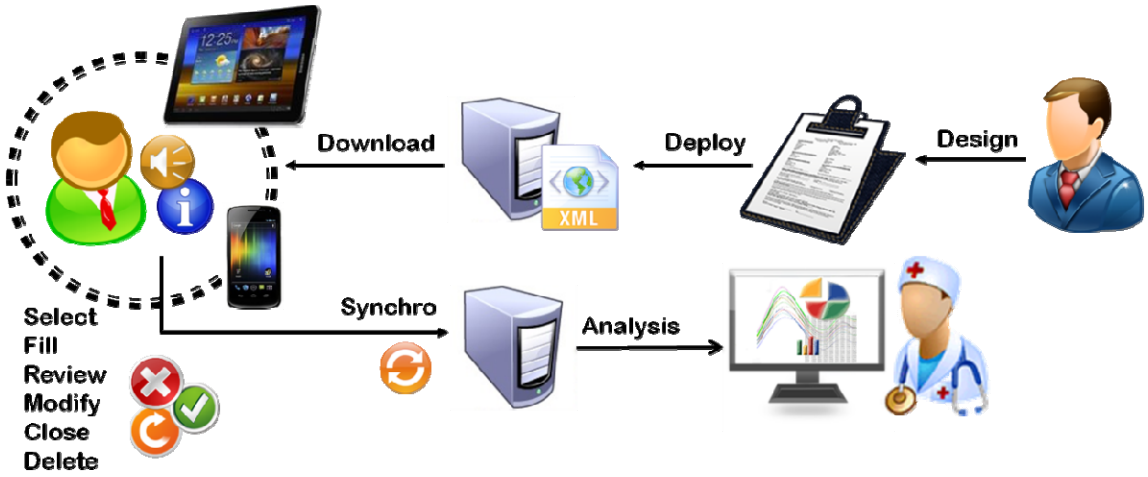


Figure 3. The functional architecture of the platform.

When the user accesses the mobile application he may *select* a questionnaire among those available in the local repository. Then he can start *filling in* answers as required by its treatment protocol. We provide two different help modes supporting the user in filling in a questionnaire. The XML model allows the definition of an associated instruction text for each question which is rendered by the application as a side note dynamically shown or hidden on user demand. Furthermore, the same model allows an optional explanation text for both questions and answers which the application renders through the embedded text-to-speech library provided by Android. Similarly when providing input the user may exploit the embedded speech recognition engine which is constrained by the type associated with the input field. Taken as a whole the possibility of using the speech both for hearing directions and entering input simplifies the task of filling in a questionnaire and improves both the usability of the application and the user experience.

The answers provided by the user are incrementally persisted in a local database so that they are not lost if the user stops a session before finishing the whole questionnaire. The next time he accesses it he faces the option of continuing with the suspended one. In that case he may *review* the previously provided answers, *modify* them and finally *close* the questionnaire or *delete* the suspended work altogether. Each questionnaire may be answered multiple times by the user according to the treatment protocol, in which case the answers will be correctly grouped together by instance and remain consistent. When a questionnaire is finished, the answers provided by the user will be *synchronized* to a database in order to perform the required *analyses* by the clinicians. The synchronization task requires authentication in order to save the results. Depending on the study each patient can be allotted a different credential for providing his answers or use a shared space enforcing anonymity.

2.3 The Computational Architecture of the Android Application

The application for rendering questionnaires has been developed on top of the Android operating system, thus it is able to run on all the android-powered devices which have very different capabilities ranging from small smart-phones to wide tablets. The feature impacting the application behavior at most is the screen size, and depending on the complexity of the information conveyed in the questionnaire it is therefore advisable to select a suitable device.

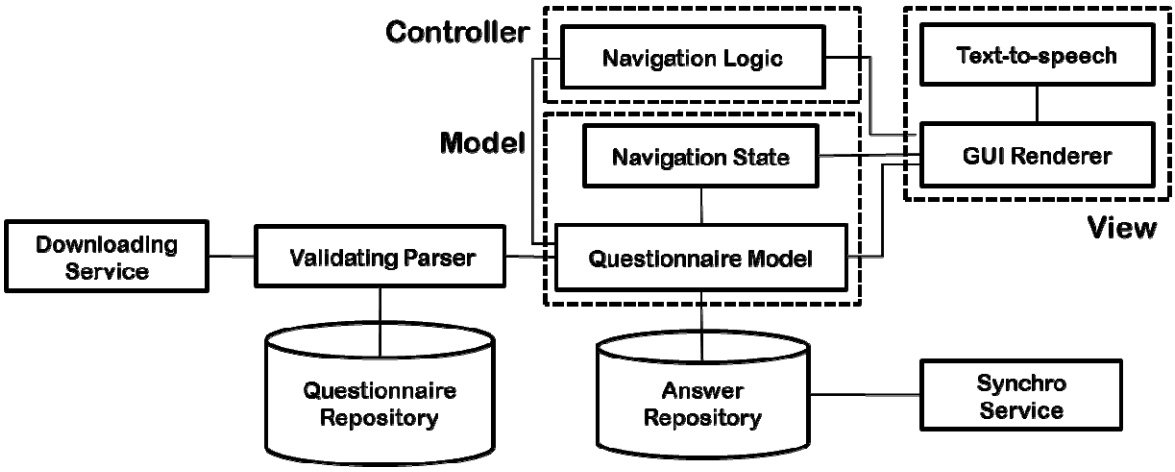


Figure 4. The computational architecture of the Android application.

Figure 4 shows the computational architecture of the Android application illustrating all the software components building it. The files including the XML representation of questionnaires are checked on the server repository through an internet connection and possibly downloaded by the *Downloading Service*. Then they are processed by the *Validating Parser* and eventually stored in the *Questionnaire Repository* where all them are available for the user selection. The parser checks each file against the structural and syntactical correctness of the included XML and creates the *Questionnaire Model* which is a memory structure used by the application for navigating across the questions. There is mostly a one-to-one correspondence between the elements available in the XML model and the object instances available in that memory structure. Among the checks enforced by the validating parser are those concerning the availability of all the required attributes for each item and the consistency of the navigation rules expressed in terms of the onfill and onblank attributes. The *Questionnaire Model* is represented through a series of JavaBeans extending a common class, which contains properties and behaviors shared by all the different elements referenced by a question. The model is also responsible for managing the user input which is saved into the *Answer Repository* and recovered from it whenever previously answered questions are revised. That repository is implemented using the *Content Provider* feature exposed by Android.

The application is shaped against the architectural pattern named *model-view-controller*. In our case the model provides the in-memory representation of the questionnaire where both the definition of the questions and the user input are stored. The view is responsible for assembling the layout of the questions and activating the text to speech concerning the help, while the controller enforces the *Navigation Logic* and the consistency rules defined in the model for the user input. Our implementation sees each model element matched with a view part responsible for producing its graphical representation. There is a single Android *Activity* for displaying the questionnaire which is dynamically updated by the view parts reshaping its layout whenever a new question is accessed. In fact the view part is responsible for creating all the widgets representing the title, labels, checkboxes, radio buttons and textual input fields according to the specific organization of the current question.

The *GUI Renderer* displays each question either in read-write mode or in read-only mode according to the navigation rules. The latest question is always editable and the user can input a value or select one from the available choices depending on the case at hand. The editable question also has the capability of displaying help messages. Those messages may also be uttered in spoken language by the *Text-to-speech* service based on user preferences.

If the user navigates backward and accesses a previously answered question, that one will be recovered from the Answer Repository with inputs precompiled and disabled. On any previous question he is given the chance to reopen it in order to modify the answer. However, since the navigation is affected by previous answers, reopening a question implies the truncation of all the input provided from the reopened one onwards. Once the questionnaire is finished, the renderer always gives the user a chance to review the full questionnaire in read-only mode, in order to delete it or accept and synchronize the answers through the *Synchro Service*.

3. DISCUSSION

Our primary interest in questionnaires was for using them in performing evaluation studies on home patients. Thus in designing and implementing our platform we addressed the typical needs of those patients, as we tried to combine the advantages of both paper and web based administration methods. More specifically, the availability of an application running on tablets for rendering questionnaires eliminates the requirement of possessing any skill on the user side for navigating the internet. The application can be started with an action as simple as a click on an icon proposing to choose one among the available questionnaires. Furthermore, the implementation on a mobile hardware improves the overall experience since the user is not required to be sitting in front of a networked PC. The task of completing the survey may be accomplished with fewer restrictions and is more comfortable for the user who can bring the device with him while he is busy with his everyday activities and answer the questionnaire in the most timely fashion. In fact, once the questionnaire is downloaded and stored in the local library, it may be accessed anytime even when no network coverage is available. The user is free to navigate among the questions he has already seen, possibly revising the answers, and when the survey is completed, the input becomes eligible for synchronization.

Another major concern affecting the quality of a survey relates to the questionnaire layout preparation. More specifically, the analysis of web questionnaires has determined that question ordering and visual disposition capture the user attention and affect the response rate [Couper, M.P., 2000]. It has been found that preceding questions may affect how users consider and interpret latter questions especially when some kind of relationship exists among them [Tourangeau, R. et al., 2004]. We capitalized on those results devising an adaptive model for representing the questionnaire, so that whole question blocks may be skipped whenever their answers can be inferred by those provided earlier or they turn out to be inapplicable altogether. Visual disposition arranges separate questions on different screens so that each one may be associated with help to support the user in providing the answers. A special effort has been devoted to implement an enhanced help supporting the user in properly understanding the question. This is available in the form of annotations to the questions but may also be rendered in spoken language using the text-to-speech engine available in Android.

Finally, an important issue for surveys is represented by the need to ensure an adequate quality for collected data. This should be achieved through a careful design phase where the researchers prepare a suitable set of questions whose answers are consistent with the study to be accomplished. However much too often a survey is deployed just to find out, soon after data collection has started, that it cannot be used for establishing valid and reliable explanations concerning the investigation because of some mistakes occurring in the way questions are structured [Saris, W.E. and Gallhofer, I.N., 2007]. As we are mainly concerned with surveys for collecting information during clinical studies we faced a similar problem when dealing with unexpected situations. In those cases there is no way to anticipate the problem providing consistent questions in advance. The only way to cope with that situation was to account for the adaptivity of the questionnaire itself. Once again, having implemented the engine as an application on a mobile device, we are able to dynamically update and download new questionnaires over the air as the clinicians deem to do so in a transparent way for the user.

4. CONCLUSION

The paper reported on a platform for administering questionnaires to patients enrolled in clinical studies, possibly involving experimental protocols. The specific application context required features not available on software in public domain, such as adaptivity in the virtual dialog established with the user and consistency checks on the answers supplied by the user. This called for the design of a questionnaire model and the implementation of an application able to run its instances. The application was developed on the Android operating system so that it is available on smart-phones and tablets, which allows for a better comfort and user experience. Questionnaires are made available on a server repository and automatically downloaded as new ones are deployed. At any time the user is allowed to select a questionnaire to fill in according to the specific treatment protocol. Once questionnaires are completed by the user, the input provided is synchronized to a server for a subsequent analysis step. The platform is currently undergoing evaluation for monitoring patients affected by atrial fibrillation.

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Short Papers

FUTURE EDUCATORS' EXPLAINING VOICES

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ABSTRACT

Teacher education programs must offer pre-service students innovative technology-supported learning environments, guiding them in the revision of their preconceptions on literacy and technology. This present paper presents a case study that uses podcast to inquiry into future educators' views on technology and the digital age. Results show future educators present rather conservative views on technology use and few of them relate to the theme from their future professional identity. Courses aimed at preparing future educators to make pedagogical use of technology should explicitly address students' preconceptions so as to favor the educational approaches required for the development of the twentieth century skills.

KEYWORDS

Technology, podcast, professional identity, education.

1. INTRODUCTION

The widespread use of Information Communication Technologies (ICT) in all areas has a direct effect upon the way in which the world is perceived. That bears profound consequences to communication and education, forcing researchers and educators to rethink social relations and knowledge construction processes under the new conditions of the digital age (Jewitt and Kress, 2003; Balagué and Zayas, 2007; Cases and Torrescana, 2007). Teacher education programs must offer pre-service students innovative technology-supported learning environments, guiding them in the revision of their preconceptions on literacy and technology. Many of such perceptions may relate "literacy" to learning how to write, "writing" to the medium of paper and "being a teacher" to the transmission of knowledge. So their higher education can effectively guide future educators in the revision of such preconceptions, professors must be able to Teacher education programs must offer pre-service students innovative technology-supported learning environments, guiding them in the revision of their preconceptions on literacy and technology. Podcasts have been shown to be a good tool for that means (Dale, 2007; Heilesen, 2010). They allow future educators' to develop an "explaining voice", a voice that performs understanding, according to Cambell (2005). Such an understanding, I believe, is essential not only for the students themselves, but also, and possibly most importantly, to their educators.

2. HIGHER EDUCATION FOR FUTURE EDUCATORS

Some literature on technology and education has developed assumption like that today's students are more familiar with ICTs than previous generations. Different scholars have made reference to this phenomenon, using labels such as "Digital natives" (Prensky, 2001a, 2001b), "Net generation (N-Gen)" and the "Generation Y" (Weiler, 2005), to quote just a few. However, there are numerous claims about the technological capabilities of these students. In fact, most of the academic research (Brown & Czerniewicz, 2010, Li & Ranieri, 2010, Romero & de Oliveira, 2011) shows such assumptions should be taken with caution. It is undeniable that a growing number of higher education students use technologies in their everyday life, however, it has been shown that student teachers undertaking higher education programs may go through pedagogical technological courses, perceive an enhancement of their technology literacy and of their frequency of technology use without experiencing any revision of their perceptions of what a good

teacher knows or does (de Oliveira et al., 2011). This is something courses aimed at preparing student teachers to make pedagogical use of technology should explicitly address. Developing technology literacy and/or incrementing the frequency of technology use is not enough to change student teachers enduring perceptions of the role of a teacher. Student teachers should be guided in elaborating new appreciations of the role of teachers and the purposes of education as they are prepared to educate the citizens of the digital age.

2.1 Case Methodology

In order to give rise to students' perceptions towards technology and the digital age, we developed this present case study. After an introductory class which required some previous theoretical reading, the case participants were asked to work in groups, develop and record a podcast. The 80 students (6 males, 74 females; 35,7% aged 20 years, 51,8%, aged 21–25, 8,3% aged 26-30 years and 2,2% over 30 years of age) are future educators (teachers, pedagogues and social educators), enrolled in a 12 ECTs course called Communicative Abilities. They are in the first year of their higher education studies. They have been chosen as participants in this case study because one of the objectives of this course is precisely to make students critically reflect on conceptualizations of literacy in a digital world.

The students worked in the groups of up to 5 participants, previously formed to develop a blog as part of the activities in the course. All classes' blogs can be found in our course blog *Més que Paraules* (http://mesqueparaules-urv.blogspot.com.es/). The groups were instructed to use their mobiles and to upload podcasts up to two minutes to Sound Cloud (http://soundcloud.com/) and post their podcasts in their class blogs. In their podcasts, students were invited to expose their views on the changes experienced in our society in the digital age. Having read some bibliography and listened to the theoretical class, the students could develop themes they thought were relevant, something which they agreed with or not, or maybe something they thought had not been satisfactorily developed.

The students' podcasts were then analyzed under a socio-cognitive perspective of Critical Discourse Analysis. We drew a list of semantic macro structures, that is, statements, topics of themes present in the students' semiotic production. According to van Dijk (2009), semantic macro structures are what discourses are globally about: "They are mostly intentional and consciously controlled by the speaker; they embody the subjectively most important information of a discourse, express the 'overall' content of mental models of events(…)" (van Dijk, 2009: 68). Podcasts have been chosen to elicit students preconceptions because they have been said to allow the production of an "explaining voice", a voice that performs understanding, according to Cambell (2005). From a pedagogical perspective, the students are invited to structure their perceptions on technology so they can reach a deeper understanding of what they think of the themes studied in the course. From a research perspective, the podcasts produced offer discourse data that allows understanding the semantic macro structures characteristic of the semiotic objects produced by the participants.

2.2 Results: Future Educators' Podcasts on Technology and the Digital Age

Table 1 presents a brief abstract of the semantic macro structures present in each podcast produced analyzed in this present case study.

Table 1. Semantic macro structures of the podcasts of 16 future educators' groups on their views on technology and the digital age

Group Name	Podcast abstract
Minds	There are changes in the way of relating and thinking brought about by new technologies. These changes have come to the classroom, but teachers still do not successfully exploit them. Teachers are poorly trained. They should be guides on the highways of knowledge and motivate students to think critically.
Let's favor good habits!	There are three negative aspects on ICT in the classroom: first, the Spanish project which aimed at offering one computer for every kid in classroom (1X1 Project); secondly, mobile phones distract students and hinder the learning process; thirdly ICT can create dependency and impoverish personal relations.

Educational frontiers	The world we live in is in constant change. ICT is a driver of this change. Technological determinism and social determinism are paradigms, different forms of understandings this reality. It is necessary to find a point of interpretation in-between.
The values	There are advantages and disadvantages of technology and technological changes for our society. Among the advantages, they mention the speed of communication, the ability to find information and use social networks. As disadvantages, they believe that we now have more contact to people through technology than without it, and that children do not play as before.
Eating healthily	The agricultural revolution, the industrial revolution and finally the digital revolution are stages of a social dynamics. Nowadays society encourages communication and fast transmission of information. It is important to be careful with the information on Internet, as it is easily manipulated.
A world of color	The agricultural revolution, the industrial revolution and the digital revolution are historical milestones that have produced social and economic changes. The group explains some features of the information society and express concern about addiction and dependence on technology.
Children's emotions	Changes caused by technology happen really fast in the lives of the people. The students explicitly say they are not against technology, but emphasize possible negative consequences of its use. They express preoccupation for technology replacing face to face meetings. The students acknowledge the benefits of the new forms of communication, but highlight we need to know to make a good use of them.
Beyond the door	Technology (internet, computers and software) has changed our lives. The students warn technology may make people lose some humanity. They also think although there is a lot of information on Internet, it does not mean that everything is good or right.
Are we solidary?	This group decides to discuss the negative effects of new technologies, focusing on Internet abuse, which may influence negatively our everyday reality. Internet, they think, presents a lot of information that may have been manipulated and is potentially false. The group thinks we must learn to select information and contrast it. The students worry about a growing neglect of social relations. They also highlight the danger of exposing kids to information which is not appropriate for their age.
Imagine all the students	For many years, the grandparents, encyclopedias and books were the sources of information people used to learn. Then, people had to meet face to face to meet and talk. But things are different now. Google, they say, has greatly facilitated our lives. The students use an ironic tone and some laughing to say Google sometimes may lie and make up data. Google is sarcastically presented as both a friend and enemy whose cousin is Facebook. The students defend a combination of traditional and new methods of communication. They express concern for people who forget that there is a life beyond the computer.
Do you love yourself?	This group presents a debate with participants expressing different opinions for and against new technologies and their use in education. In the debate they fail to reach a shared conclusion and believe that everyone has the right to think differently.
A world to educate	Technologies have a great impact on children now. Educators need to learn to use them to reduce the communicative gap between teachers and students. More than knowing how to use technologies, teachers should be able to adapt them to their students' educational needs. Educators can turn cold technologies in warm social relations media, helpful to educators' objectives. We can find positive things in the past, in the present and in the future. It is important to know humanize this increasingly virtualized world.
Cartoons again	Technologies evolve quickly, having as a direct consequence, the rise of an increasingly globalized world. There are pros cons of the rapid pace of the new technologies evolution. Among the pros, students claim that ICTs make communication easier, favor interaction, and promote multiculturalism. Amongst cons students say technologies can create dependence, reduce freedom and remove people from the world of real warm relationships. The group is highly concerned about making a respectful use of ICT.
Social Abilities	Schools face difficulties to adapt to students being connected to ICT on a daily basis. Even small changes that schools and teachers can do to integrate technology in their educational approaches are important. Schools have to promote creative leadership and teacher training. Teachers must be willing to share their knowledge and be flexible. Schools should adopt innovative and adaptive management.
Learning from nature	Society has always evolved using all available resources in different periods of its history to make life easier. Today's digital technologies are part of the daily lives of people and spaces are interactive, explorable, mobile and changeable.
Playing and learning!	Since the beginning, mankind has adapted through new technologies. Technology is intrinsic to human development. ICT has a positive and negative side: it all depends on the use we make of it. As positive aspects of ICT, the students mention the socialization of culture and knowledge, as well as the possibility of instant communication. As negative aspects, students say ICT can be impersonal and that sometimes the information is doubtful.

2.1.1 Discussion

An analysis of the macro semantic structures present in the podcasts produced by the future educators shows their views on technology and the digital age can be said to fall under four broad blocks of themes:

First block – Neutral statements regarding technology and society: Technologies create an increasingly globalized world; Technologies bring about changes in the ways of relating and thinking; ICTs promote speed of communication, availability of information and the use social networks; and finally, ICT favor culture and knowledge socialization. Though most of the groups which have mentioned these topics mention them as positive aspects, I have preferred to refer to them as "neutral" because they state an acknowledgment that technology is part of our lives now. 13 out of the 16 podcasts make reference to these statements.

Second block – Statements of caution: There should be balance in the combination of traditional and new methods of communication; It is important to make a respectful use of ICT. 7 out of the 16 podcasts make reference to these statements.

Third block – Negative statements: Technologies can impoverish personal relations, dehumanizing them; ICTs can create addiction and dependency; Information available on Internet may be false and manipulative. 10 out of the 16 podcasts make reference to these statements.

Fourth block – Statements regarding technology and education: Teachers should motivate students to think critically; Teachers still do not successfully exploit technologies; Teachers need to be trained to use technology for pedagogical purposes; Educators can turn cold technologies in warm social relation media, helpful to educators' objectives. 3 out of the 16 podcasts make reference to these statements.

It is interesting to notice how conservative the students participating in this study show themselves regarding technology and the digital age. Most of them express concerns which have to be explicitly addressed by their educators in order to open their minds to models of education which will promote the required skills of the twentieth first century. For example, students should be guided in the understanding that television, radio and books and even face to face encounters may convey manipulative false information too. Besides, only 3 out of the 16 groups expressed some form of educational preoccupation, which indicates their reflections are elaborated from a very initial, still to be formed professional identity.

3. CONCLUSION

So that future educators are able to elaborate a professional identity which encompasses the pedagogical uses of technology among their range of ordinary duties, their educators should provide them with an environment that favors enough flexibility to self expression and serve as a meta-exercise, through which future educators can elaborate new appreciations of the role of teachers and the purposes of education in the digital age. Guiding students in the identification of semantic macro structures in their semiotic production, so they realize a deeper understanding of their own voices, can be an exercise that leads to the development of a more critical and reflexive professional identity.

Higher education professionals and researchers should not take for granted that as students live surrounded by technology, using them on a daily basis, they should have favorable perceptions on their educational use. Whatever level of familiarity future educators have with technology when they come to the university, they also bring some preconceptions and misconceptions on what literacy means and on what are the means of literacy. It is important to bridge students' previous knowledge, which is both technical but also philosophical, regarding technologies to richer levels of understanding of the role of twentieth first century educators. Podcasts seem to offer a tool just as good to build such a bridge.

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A FRAMEWORK FOR THE CREATION OF MOBILE EDUCATIONAL GAMES FOR DYSLEXIC CHILDREN

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ABSTRACT

Dyslexia is a reading disability that can, in some cases, be cured. The most frequent treatment for dyslexia consists on repeatedly performing certain word exercises. Because most dyslexic patients are young children, most applications for word training are games. The development of such games is costly and it involves different parts (developers, psychologists, etc.). In this paper, we analyze and review the advantages of mobile devices in education and healthcare and present a framework for the creation of games for vocabulary training on mobile devices. The main goal of the framework is to enable the reusability of features typically present in applications for dyslexia training. The main advantage is the rapid development of such games by reducing the dependency of collaboration between developers and experts in the field. We also demonstrate the usage of our framework in the creation of a simple game called ReadPoker.

KEYWORDS

Dyslexia, educational games, mobile games, legaframework

1. INTRODUCTION

Dyslexia is a term used to describe a learning disability that hinders affected people from both, reading fluently and comprehending what they read. This disability is often treated by repeatedly solving reading and writing tasks. A big challenge, particularly when treating dyslexic children, is to keep them motivated in order for them to continue practicing. Because of their motivational power, games are often used to treat dyslexic children.

The development of such games is often complex, mainly due to the knowledge gap between the different stakeholders involved in the creation of the game. Another challenge is to keep the balance between entertainment and learning features. Games created without the involvement of experts in the field, are likely to tend towards “fun”, leaving the “seriousness” of the game aside. Most of the existing games, however, are simple word puzzles that fail to produce player’s immersion, as they lack a game story, among other game features. Additionally, most games target desktop platforms, despite the fact that dyslexia is often diagnosed in early ages, when children’s motoric skills are not yet fully operational.

We propose a framework for the creation of mobile educational games for dyslexic children. The purpose of the framework is to allow the construction of games for dyslexic children by reusing features and content usually present in such games. The framework is constructed in such a way, that entertainment and educational features are decoupled from each other. It also allows developers and experts in the field of dyslexia to work independently on a common game project, which suggests less communication overhead.

The contribution of this paper is twofold: first we introduce the framework and its main components, and then we describe how it can be used to create a game with relatively little effort.

2. THEORETICAL BACKGROUND

2.1 Dyslexia

Dyslexia is characterized by difficulties with accurate and / or fluent word recognition and by poor spelling and decoding abilities (Shaywitz, 2005). Three types of dyslexia have been identified. The so-called trauma dyslexia is a type of dyslexia caused by a serious illness or brain injury. The primary dyslexia is another kind of dyslexia caused by a dysfunction of the brain. This dysfunction is however caused by genetic factors and does not change with age. The third type of dyslexia is called secondary or developmental dyslexia. Patients of this kind of dyslexia usually present standard IQ levels and sensory abilities but still suffer from deficits in reading (Démonet, 2004). The only known way to improve this condition is continuous practice.

2.2 Mobile Games for Education

Several researchers (Gee 2008, Prensky 2008) have discussed how the experience delivered by games can contribute to our everyday learning. Games are mainly used in education because of their ability to motivate and engage learners. As they offer more interactivity and immersion capabilities than other instructional media, learners may sometimes not even perceive playing as a learning activity. Indeed, this is the goal of most educational games, despite the criticisms in (Papert, 1998).

Games also result advantageous due to the fact that they allow abstract concepts learned in a classroom to be contextualized. Learners can then apply the concepts in concrete situations rather than simply reading or hearing about them. This contextualization takes place without the risks or impossibilities of real life. Further, games allow situations to be repeated immediately in the exact same way as much as needed.

Mobile devices can be beneficial in the context of education for different reasons. First, their multi-touch capabilities favor collaborative problem solving, which enhances learning (Wang, 2009). Additionally, the fact that mobile devices can be used in different environments suggests better opportunities for students to apply learned concepts outside of the classroom. Mobile devices offer a more direct way of interaction and usually highly intuitive user interfaces, enabling their usage by younger children.

3. RELATED WORK

There exist several approaches that try to improve the problems based on developmental dyslexia. A teaching approach that has gained acceptance in the last decade is known as the *multisensory approach*. It relies on connecting the written form of words with related visual and acoustic elements. It is the most effective teaching method for children with learning difficulties (Ohene-Djan et al., 2008).

(Merzenich et al., 1996; Tallal et al., 1996) showed how a computer game that stretches or slows down word phonemes can help dyslexic players improve reading by developing learner's auditory discrimination and phonological awareness. (Kujala et al., 2001) showed how students with dyslexia who received audiovisual training improved their reading skills by matching sound patterns to their visual representation. (Shaffer et al., 2001) showed how a computer tool could evoke and reinforce certain brainwaves causing a significant improvement in student's motor control, as well as language and reading skills.

Despite some interesting findings in the field, (Torgesen, 2001) points out that typical school interventions for children with reading disabilities *stabilize* the degree of reading failure instead of *normalizing* the learner's reading skills. This is mainly due to insufficient budgets and overcrowded classrooms. While automatic adaptivity of software tools could help overcome the problem, (Ohene-Djan et al., 2008) remark the lack of learning technologies able to even identify learner weaknesses.

The industry faces similar problems. Most games for vocabulary training save budget on pedagogical insight and present tasks such as correcting wrongly written words or finding words in clouds of letters. Based on today's studies, this is not recommended anymore because of the risk that learners memorize incorrect spellings of words. According to (Naegele, 2001) and (Meumann, 1914) children learn words more effectively when they are shown the correct spelling of words from the beginning.

4. LEGAFRAMEWORK

The goals of the *LegaFramework* are to simplify the development and ensure the quality of games for vocabulary training by reusing available components. As an example, game assessment strategies are given to developers, who can therefore focus on game-specific features such as the logic of the game, user interface, etc. The framework is based on iOS and supports iPhone and iPad development. It consists of four different modules: *Content*, *Style*, *Adaptivity* and *Assessment*. Figure 1 illustrates the different modules and their interaction.

The *Content* module provides an abstract interface to content elements, such as words. Words are represented in four different ways. The first one is the regular written form of the word (e.g. "Coffee"). The second is a representation in which the core difficulty of the word is blanked out (e.g. "Coff__"). Furthermore, a word is represented by an image and its spoken representation. Each word is further categorized into a problem group, such as "words with double vowels".

The *Style* module is responsible for displaying content in a suitable way for dyslexic children. It uses the *Andika* font that was developed for high legibility and uniqueness of each letter, which makes it easier for dyslexics to read. It further ensures the appropriate dimensions of labels and images, such that users can interact with them. The Framework foregoes any configuration here to guarantee that developers won't use ineffective fonts, font-sizes or inconsistent images.

The *Adaptivity* module takes care of adjusting the game's difficulty to the player. Developers can configure when the game will automatically change to a more or less difficult situation by mapping player skills to difficulty levels. Currently, the framework knows three different difficulties that are: 1) word and image are displayed, 2) the word is displayed with blanked core difficulty together with the image and 3) only the image is displayed. As adaptivity strategy the framework uses simple counting of correct and wrong solutions.

The *Assessment* module stores every solved task and calculates player skills. Developers interact with the *Assessment* module by specifying the event type (correct or wrong answer events) and the corresponding content related to it (task, word, etc.). These results not only serve as input for the *Adaptivity* module but can also be displayed in the form of a table, as shown in Figure 1. This information is useful for therapists and / or parents in order to see the player's progress and to analyze what problem group they have the most difficulties with.

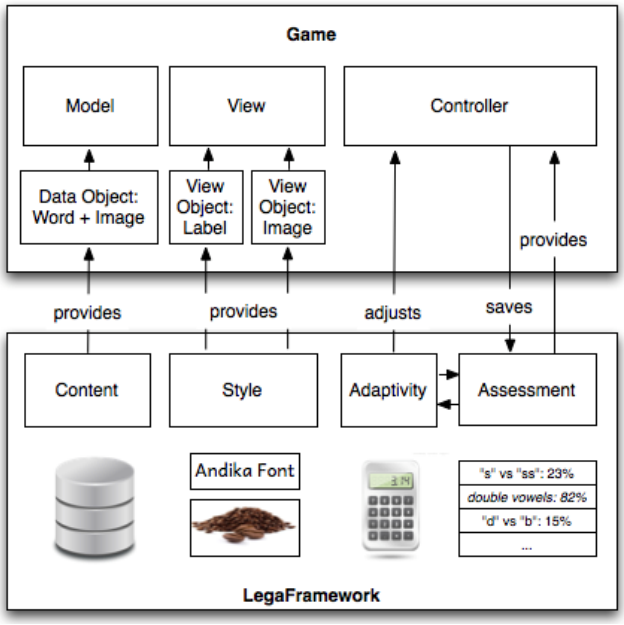

Figure 1. Model of LegaFramework's modules and its interaction with a game

5. CREATION OF A GAME USING LEGAFRAMEWORK

To assess the usage of our framework, we made use of it in the creation of a simple game we called *ReadPoker*. In this game, the player receives five cards that show either words, images, or both. In order to win, the player must select the appropriate cards depending on the current task. As an example, the player may be asked to select every card with double vowels. Figure 2 (left) illustrates the main interface of the game.

LegaFramework's content component is used to fill the cards with content, and the Style component to generate the corresponding view objects out of the content objects. As illustrated in Figure 2 (center), the Content module generates the word and image objects and the Style module provides an appropriate representation for them, which can be added into the game directly.

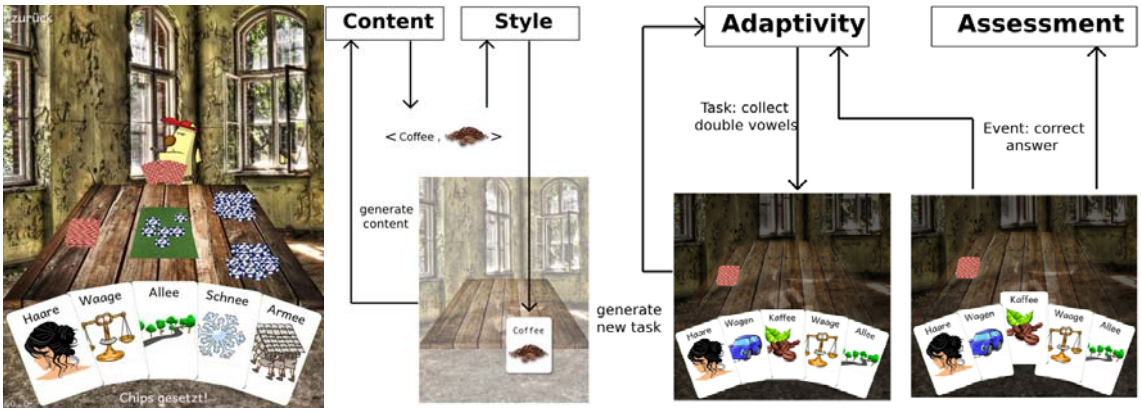

Figure 2. (Left) ReadPoker main interface. (Center) Content generation and representation. (Right) Communication between Game and Adaptivity and Assessment modules

The Adaptivity and Assessment modules are used to provide behavior to the game. The Adaptivity module is responsible for generating new Tasks according to the player skills. A player with low skills will get easier tasks such as collecting double vowels on cards where words and images are fully visible. The more chips a player wins, the higher the probability that new tasks will include words with blanked letters.

The Assessment module receives game events such as correct or wrong answer events and groups this data in a meaningful way in order to determine players' skills. This is illustrated by Figure 2 (right).

6. CONCLUSION

We showed in this work how game developers could add learning features and content to games for dyslexic children without going through the hassle of understanding the problem domain. Based on our experience in the field and interviews with experts, we were able to identify major components needed for such games and integrated them in a framework, from where they can be reused. We demonstrated how the framework enables the creation of a compelling mobile game without major effort.

Tablet devices provide a more direct way of interaction, allowing children even without computer experience to interact with objects on the screen by literally touching them. Additionally, mobile devices do not enforce a usage at home and can be used simultaneously by more than one user. This suggests better opportunities for collaborative playing, and it also facilitates its usage in the context of a therapy.

While reusing existing components enables game creators to save time, this comes at the cost of a reduced flexibility when realizing game specific features. In order to refine the abstractions used by the framework, we are currently planning to use it in the creation of more complex games.

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MOBILE LEARNING 4ALL

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ABSTRACT

We are in an innovation process for the development of a new generation of tools and resources for education and training throughout life, available in any platform, at anytime and place and in any language. The project TOPQX intends to congregate a set of theoretical and empirical resources that form a scientific base from which it will be possible to question and to suggest new answers, fitting the requirements and interests of the users of these resources. As an output of these efforts two multiplatform and multi device products will emerge: Vox4ALL® and ActiveBrain4ALL.

KEYWORDS

Augmentative and Alternative Communication (AAC); Mobile Learning; Symbol Systems; Active Aging; Brain Gym, Vox4ALL; ActiveBrain4ALL; Multiplatform.

1. RESEARCH CONTEXTUALIZATION

Having into account the diversity of the populations with which we intend to interact, project TOPQX does not have, from the methodological point of view, only one predefined strategy. To present an innovative solution, that benefits the target population, we need to know who they are. Facing the heterogeneity of the contexts and experiences of the involved populations, we foresee different research challenges and the use of different methodological resources.

When we identify more specific needs and problems that affect a defined population the case study can be one of the techniques to considerer. With the objective of systemize our research work in this project, we opt to following the strategy suggested by Yin (2005) for the Case Study. Considering, with Stake (2005) that the case can be a person, a program, or a set of programs, a group of professionals or another category that can be seen as an unit of analysis, we propose three sequential procedures: the definition of the case to study; the multiple option for an only case or cases; and the deepening of a problematic that bases the protocol for gathering the empirical information and the analysis guidelines of the collected data (Yin, 2005).

The research that we report here, although exploratory, had close followed this methodology. The retrieval, observation and comparative analysis of the different available applications and the retrieval of data within the groups for whom these applications are made were conditioned, in the research carried through in the subprojects Vox4ALL and ActiveBrain4ALL, by the two cases that we intended to explore. The first one appeared of the need to implement a system that served a population that presents sensorial, cognitive or motor disabilities, permanent or transitory, that compromises its communication capacities. The second one is a solution thought for the adult population at any time, in any place and any language, who needs to keep active the mental and social abilities.

In parallel, and with the objective to get quantitative data, the two studies had appealed to the technique of inquiry questionnaire. The collected data had allowed that the first specification resulting from the studies of benchmarking and the vision of the project team could be adjusted and collated with the opinion of a set of technician specialists.

Later on, a specialist's focus group will add a critical insight on the specification. The potentialities of this technique are multiple. The technique helps, at an initial moment of the research, the reshape of the questions, or even the emergence of new research questions, from a first empirical approach to the thematic. As Kruger and Casey say: "The purpose in the focus group is to listen and gather information. It is a way to better understand how people feel or think about an issue, product or service" (Kruger & Casey, 2000).

Moreover as Virginia Ferreira explains: “In the base of the option for this type of interview it is the certainty that it is possible to know the attitudes, the beliefs and the feelings of the people better, when they meet in group interaction, because the group situation favours the emergence of one bigger multiplicity of opinions and emotional processes, much more limited in the situation of individual interview” (Ferreira, 2004).

Finally, we consider that the triangulation of the different types of information, collected by diverse techniques, should be a preferred strategy in the research process of the TOPQX project. Only convoking various perspectives in this analysis, crossing data and procedures, we will be able to assume the accuracy and to strengthen the validity of our projects.

2. TWO DIFERENT PRODUCTS

We will present the innovation process of two multiplatform and multi device products from the initial idea to the first specification, through benchmarking analysis, online questionnaires and focus groups.

2.1 Vox4ALL

Communication is a complex and basic process for the development of the human relations. When communicating, the more used way of expression is to talk. To speak not only empower the human’s interactions, but also develop the cognitive skills and thought, allowing new and more elaborated learning. However, “a significant number of the population is unable to communicate through speech. These may be people totally unable to speak or cases in which speech is not enough to fill all the communicative functions” (Tetzchner & Martinsen, 2000). The causes can be innumerable, from the bad use and vocal abuse to hearing, cognitive, neurological, emotional and amnesic disorders, to cerebral injuries, cerebral paralyses or vascular accidents (Franco, Reis & Gil, 2003).

To override the necessity of communication, intrinsic to the human being, it is important to provide to these people, as early as possible, a System of Augmentative and Alternative Communication (AAC). Many times, a system of communication functions as a tool to fight to the already mentioned disorders, constituting “a set of techniques, aids, strategies and skills that a person without oral communication uses to replace or minimize their inability to communicate through speech” (Nunes da Ponte & Azevedo, 1998) and also, in some cases, to promote the speak competence.

Traditionally, these systems were available in paper, specialized voice recorder devices and computers.

The development of these systems is guided by the Augmentative and Alternative Communication (AAC) that appeared in the United States of America, in the eighties, resulting from a multidisciplinary work that recognizes the right to communicate to all the individuals without exception.

In recent years several solutions have appeared that override the communication gaps, as software like Communicate with Symbols. However, these systems do not answer efficiently to the mobility needs. As we know, the users of these systems need to communicate in different spaces, for example, at house, at school, at public services, hospitals, etc., so mobility is a must have.

On the other hand, innovations are not always immediately introduced by who can recommend them, causing sometimes devastating consequences, avoiding the success of learning a multimodal communication system (Beukelman, Fager, Ball, & Dietz 2007).

Imagina is developing an AAC system, capable to migrate between different mobile devices, conferring to disabled users the possibility of getting a normal life, granting to them the capacity to communicate in all the contexts and spaces. The Vox4All is a solution thought for tablets and smart phones based on communication grids, with the main aim of minimize communication problems and enhance communication competencies.

To create communications boards adapted to the communicative needs of the users we will use a pictographic system, the Widgit Symbols for Literacy, although the users can choose another one. This communication system allows people, of different ages, with communication difficulties, to interact with others, expressing their opinions, wishes, feelings and decisions.

In our first phase for creating the new system, it was carried out a benchmarking study, that allowed, among other things, to conclude that in Portugal it is not available any application developed under these

principles, combining portability with well established AAC systems. The same is not true in other countries, where we found several applications trying to overcome this need. From this analysis become evident a common set of functionalities to be included in a product that intends to cover a vast group of people with communication problems, definitive or temporary, independently of the degree of incapacity and age. These features are the possibility of using images, symbols and pictures, synthetic or recorded voices.

However, a truly new product must be planned to go beyond benchmarks of the industry. There are two fundamental aspects we will look into: The power to build communication interactive boards on the mobile devices and the usability of the application. The application should be simple, intuitive and inclusive so that can match all type of users. As the target group is very heterogeneous we need to provide different ways of accessing and using the software. Some people with severe communication impairments can use their hands; others cannot, for example, people with severe motor disabilities will have to use alternative ways, such us scanning systems and adjustable ways on how to click.

It was also carried out a survey using a questionnaire to rehabilitation professionals: speech therapists, special education teachers and psychologists, among others, that somehow deal closely with potential users of our communication system. The questionnaire aimed to understand what professionals hope to find in this kind of application and what they believe it is more important.

Moreover, the product is thought to benefit from the advantages of the new touch screens, combining easiness of use and agility, with enhanced user interaction. The specification of the product was founded on the benchmarking study, being complemented by the insights resulting from the data collected through the inquiry questionnaire.

2.2 ActiveBrain4ALL

Aging has been increasing; being one of the main reasons for this phenomenon the enlarged life expectancy. Not only in Portugal but also across Europe, there has been this trend: involution demographic fits into the mainstream of the population dynamics of developed countries and the world's population.

This fact provokes a new attention to a more active aging, with quality of life and autonomy in the elderly people. This debate relates to the fact that the increase in the average age of the population has resulted in a higher incidence of chronic degenerative diseases, with dementia being one that has more impact on the lives of seniors and their families. It is common knowledge that with the arrival of old age appears a greater slowness in cognitive processing. At the same time attention and concentration become more difficult and memory impairment get more frequent.

Senescence is revealed in neuropsychological changes, especially as cognitive deficits, changes in memory and speed of thought, expression of episodes of confusion, psychological disturbances and changes in activities of daily living, which may relate to depressive symptoms and dementia. This has a number of repercussions and represents a barrier to social inclusion of the elderly, leading to a greater concern with the improvement of active and healthy aging.

However, the concept of the elderly has also changed over the years. Currently seniors are increasingly present in different segments of society and therefore a new vision of aging is needed with emphasis on a matter of extreme significance, cognitive rehabilitation that focuses on cognitive function loss and aims to improve the patient's condition both within neuropsychological side and quality of life.

In order to counter the prevalence of these diseases, the OMS (2002), has addressed fruitfully active aging, describing it as the process of optimizing opportunities for health, participation and security.

This organization has set as determinants of active aging access to health and social services; the adoption of healthy lifestyles, active participation in physical activity, healthy eating and optimization strategies and compensation of cognitive functions. In fact there is also abundant literature that reveals that the practice of physical and mental activities reduces the risk of developing dementia (Karp, Paillard-Borg, Wang, Silverstein, & Winblad Fratiglioni, 2006).

Some authors showed that high levels of physical, mental and social activities reduce the risk of dementia and if two or three components are associated then risk reduction is even more pronounced (Karp, 2006). It is, therefore, a need for greater concern to understand what the needs of the elderly, mainly in cognitive aspects, in order to slow aging and related degenerative effects of diseases such as Alzheimer's and other dementias.

In fact, the drilling of memory is essential for the promotion of healthy aging. A major cause of depression in the elderly is caused by consciousness of the decline in cognitive abilities and concentration difficulties.

In recent years there have been several studies that promote and certify that the achievement of certain games can be a good strategy to maintain and regenerate the memory (Churchill, Galvez, Colcombe, Swain, Kramer & Greenough, 2002).

On the other side, some authors refer that there is a brain capacity of recovery from the neuropathological damage related to aging and that this capacity can be increased by encouraging a more efficient use of brain networks (Katzman, 1993 & Stern, 2002).

Just for not promoting passivity of the elderly today, and taking advantage of technological developments, Imagina wants to develop ActiveBrain4All, an online platform with cognitive games for brain gym promoting active aging and rehabilitation. This platform is intended to cover not only the elderly but also younger age groups who want to maintain their cognitive abilities and people who have some cognitive impairment or brain injury. The exercises intended to be planned will be directed and focused with the objective of stimulation and reorganization of cognitive areas in deficit through different games that work on various cognitive areas: memory, attention, language, reasoning, concentration, among others.

Before training, people will take a preliminary assessment for adjust the user profile, in order to understand their specific needs, what areas they are stronger and weaker, planning the intervention more efficiently. The purpose of this pre-test is to ensure that training is not applied indiscriminately, but according to the specificities of their needs. Besides the battery of games for training, the platform will have several tools to allow communication and social interaction with other users, family relatives, friends, neighbours and medical care staff.

Initially we performed a benchmarking study analyzing several platforms of this type. We found a set of common characteristics to all of them, which proved to be extremely important to consider from the first stages of our design process. But we pretend to go further taking advantage of the portability that technological evolution gives us (an essential component of this vision) to extend this platform from PCs to smart phones and tablets, encouraging greater involvement of the elderly in society, preserving health and promoting greater control over their own life.

In addition, we conducted a survey that allowed us, among other things, to assess the usefulness of such a platform and how we can maximize and adjust it to the real needs of the target population. The set of questions was directed to rehabilitation technicians, therapists and caregivers, among others.

3. ALL DEVICES, ALL OPERATING SYSTEMS - TECHNOLOGICAL CHALLENGES

On the last few years there was several improvements on technology creating smaller and easier devices for mobile work and mobile learning. 90’s brought smaller phones with more than basic functionalities: calculator, scheduler and basic games. In the end of 90’s market begun growing for business smart phones, leaded by Nokia and palm phones. In the last 5 years, with iPhone operative system, the iPad appears. It becomes a huge hit all over the world, with Android devices trying to catch up, with cheaper alternatives.

During 2012, just on the first two Quarters, almost outsold the total number of units sold on previous year. The gadget market, it’s growing fast, but without common compliance, making apps that can run in so different devices with different operating systems and versions it is a great challenge for mobile learning.

HTML is an old standard, but lack of functions for the modern systems needs. So all the web browsers begun to implement a new common standard for the new needs - HTML 5. Created on 2004, by Web Hypertext Application Technology Working Group (WHATWG), together with World Wide Web Consortium (W3C) it suffer a lot of improvements until today. This technology was known by the world at April 2010 after Steve Jobs issued a public letter titled "Thoughts on Flash". Last year, Adobe, has discontinued flash for mobile, and begins to create HTML 5 tools to replace flash technologies. Since then several companies adopted HTML 5 as a new standard. Microsoft implemented HTML 5 as the main technology on metro environment at windows 8; Adobe created the Edge suite for HTML 5; Facebook uses it, on the mobile version. The Financial Times swapped its mobile app for an HTML5 web-based app that is now more popular than the native app (Reuters).

In order to achieve that our applications will run and migrate between almost any kind of platform and device, we will use HTML 5 as the main programming language. Anyway we are aware that this may be not entirely possible and we are considering also other alternatives that can better deal with the different capabilities of different devices and operating systems. This is a big challenge that we only are pointing on this paper. Our main concern is to get out with applications that will run in any operating system and device and that can migrate between them in a transparent and consistent way for the user.

4. CONCLUSION

Most software enterprises are creating software that can work natively or using virtual environments (like JavaScript) in the main platforms. Imagina within TOPQX project is following this trend, creating software using both methods: native, using cocos2d-x(c++), and HTML 5, running in the browser device. The first method brings more solid experience to the user, the last one brings an unique experience in web environment. Both of them work on the main systems (windows, Mac, Linux, iOS, Android). Both Vox4ALL and ActiveBrain4ALL will be developed with these technologies in mind so they can run and migrate between almost any mobile gadgets.

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LOCATION-AWARE MOBILE LEARNING OF SPATIAL ALGORITHMS

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ABSTRACT

Learning an algorithm – a systematic sequence of operations for solving a problem with given input – is often difficult for students due to the abstract nature of the algorithms and the data they process. To help students understand the behavior of algorithms, a subfield in computing education research has focused on algorithm visualization – learning material showing the steps and data used by an algorithm. As the use of mobile devices has risen together with the capabilities of the devices, mobile learning is more important then ever. It also opens possibilities to contextualize the learning experience. In this paper, we present our work towards location-aware mobile learning of spatial algorithms that adapts the learning material to the location of the student.

KEYWORDS

Spatial Algorithms, Location-Aware Learning, Algorithm Visualization

1. INTRODUCTION

An *algorithm* is a set of rules for a sequence of operations typically used for some input data to solve a calculation problem. For example, sorting emails in inbox based on the subject or finding the fastest bus-route from place A to B. In Computer Science (CS) education, algorithms are an important topic for students to understand. They should be able to choose and compare different algorithms for a given problem in programming. However, in programs, the algorithms work on abstract data, making learning and understanding algorithms difficult for students. To help students, numerous *algorithm visualization* tools have been developed (see, for example, Malmi *et al.* (2004) and Rößling and Freisleben (2002)). The educational tools visualize the data used by the algorithm and the sequence of operations it performs on that data. *Spatial Algorithms* are an area of algorithms that work on data tied to locations. For example, testing if a data point falls inside a certain area on a map could be solved with a spatial algorithm. Algorithm visualization tools for spatial algorithms have also been developed (Nikander *et al.*, 2010).

Mobile devices nowadays include more and more sensors and modern smartphones are able to get a location of the device. Location is one of the most-often used attributes to provide *contextual-learning.* That is, learning experience changes based on the context. Wang (2004) defines this context to be made of six dimensions: identity of the learner, spatio-temporality, facility, activity, learner, and community. In this paper, we focus on the spatio-temporal dimension, more specifically location-aware learning.

As spatial algorithms work on location data, using maps to visualize that data is natural. Existing educational systems like the spatial extension to the TRAKLA2 learning environment by Nikander *et al.* (2010) work on abstract data and do not use maps. In the work presented in this paper, the goal is to provide engaging algorithm visualizations for learning spatial algorithms that change based on the user's location. In this short paper, we present our work in progress towards that goal.

The rest of the paper is structured as follows. Section 2 briefly presents related work on the fields of educational (spatial) algorithm visualizations and location-aware learning to provide context for our work. Section 3, in turn, describes our new location-aware content for spatial algorithms. Finally, Section 4, discusses the contributions and the planned future of this project.

2. BACKGROUND

Algorithm visualizations (AV) are actively researched for computer science. There are more systems developed than can be mentioned within the page restrictions of this paper. The systems range from those targeted for a single topic to those being general and applicable for (almost) any algorithm. The AV research suggests that user engagement of the AVs is the key to educational effectiveness (Naps *et al.,* 2003; Hundhausen *et al.,* 2002). A good example of engaging AVs is the TRAKLA2 system (Malmi *et al.,* 2004). In TRAKLA2 exercises, the student has to simulate the steps of the actual algorithm by manipulating visualizations.

There are several tools for learning a single spatial algorithm, such as the one by Fisher (2004) for Voronoi diagrams. However, they typically only let students view a visualization instead of engaging them more. Furthermore, there are relatively few educational systems capable of visualizing multiple spatial algorithms. Only such system we are aware of is the spatial algorithm extension to the aforementioned TRAKLA2 system (Nikander *et al.,* 2010). In the exercises provided by the extension, a student has to manipulate visualizations to mimic the behavior of the actual algorithm. Equally engaging, though only for one algorithm, is the exercise for Dijkstra's algorithm introduced by Karavirta and Korhonen (2012). That exercise is also similar to the work presented in this paper in that it uses a map to visualize authentic location data.

There are many definitions of context-aware computing and context-aware learning (see, for example, Wang (2004)). However, location is part of the variables of the context in practically all of them. Indeed, location has been widely used in mobile learning to adapt the learning experience. For example, situated simulations (Orkelbog, 2010) use location as one parameter in an augmented reality learning application. Another area where location has been used as part of the context is language learning (Kasaki *et al.,* 2012). Moreover, it has also been used in location-aware learning of natural sciences (Chu *et al.,* 2010).

3. LOCATION-AWARE CONTENT FOR SPATIAL ALGORITHMS

To provide location-aware algorithm visualizations for spatial algorithms, we have implemented a simple JavaScript library that helps creating such AVs. We have used the library to create content for two algorithms: kd-Tree and Point-Region Quad-Tree. For the PR Quad-Tree algorithm, there is a visualization for two modes: *learning* and *assessment* (for kd-Tree, only learning mode is currently supported). In the learning mode, the student can view the algorithm process a set of data. In assessment mode, the student needs to simulate the algorithm.

3.1 Learning Mode and the User Interface

In the learning mode, the student gets visualizations of the selected algorithms. The visualization shows each step of the algorithm processing the random input data. Student can control the visualization by moving steps backward and forward or to the beginning or the end. Each step in the visualization includes an explanation on what the algorithm does at that point. Furthermore, the visualization of the tree data structure used by the algorithms as well as the tree visualized as a map are shown (see Figure 1 for an example).

The interface for the existing visualizations has the same components. Figure 1 shows an example of the kd-Tree visualization. In the top, there is the name of the algorithm as well as text that changes based on the state of the visualization. In the learning mode, it has explanations of the current step of the algorithm. The bottom of the screen contains buttons to control the visualization and a progress bar. The majority of the screen in the middle shows the data structures and the data on a map used by the algorithm.

In both learning and assessment modes, the visualization content checks the location of the student's device and initializes itself with data points for real locations around the student's location. The data points are randomized every time the visualization or exercise is loaded, so student can view different examples and try solving the exercise multiple times.

All the visualizations support screens of varying sizes. The content resizes itself based on the available space. Thus, they can be accessed and used on device with any size of a screen. Naturally, there is a lower limit for the screen size, below which the visualizations are not usable.

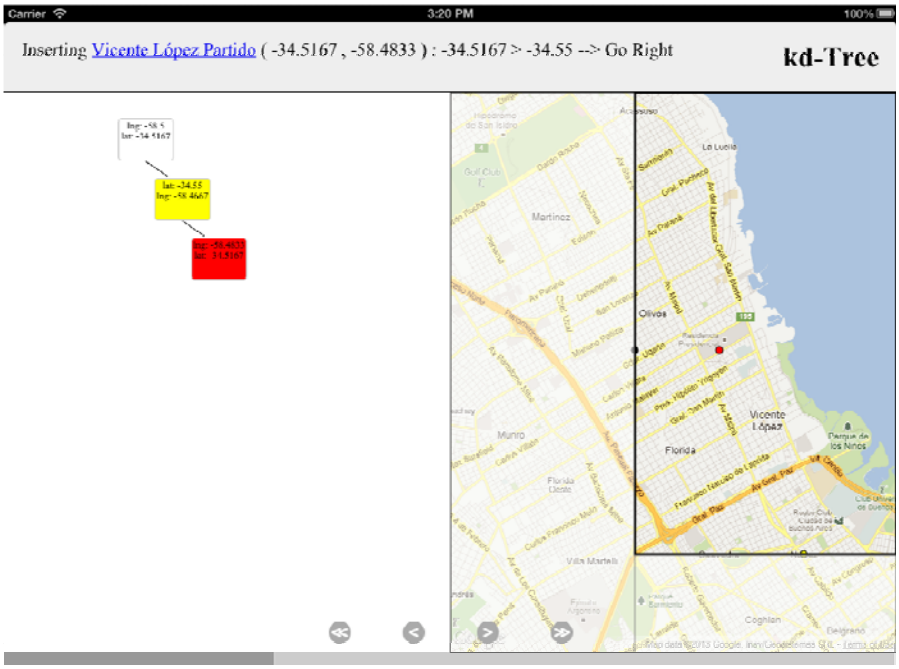

Figure 1. Example of the kd-Tree visualization in learning mode on the iPad. The red circle on the map is a point that is currently being inserted.

3.2 Assessment Mode

In the assessment mode, student has to interact with the data structure to simulate the algorithm. To explain this interaction, an example of the PR Quad Tree visualization in assessment mode is shown in Figure 2. Student's task is to insert the locations into the data structure following the algorithm in question. In the figure, the student has selected a node in the tree by clicking or tapping it. Selecting an empty node will insert the data into the node. Selecting a node with an existing value (like in the figure) will show the *"Split"* button. Pressing this button will split the node (and the matching area on the map) into four sub-areas. To complete the exercise, a student needs to find the correct positions for all the input data locations and split the nodes as necessary. Although students interact only with the data structure, the map is constantly updated to match the state of the tree structure.

In the bottom of the screen, student sees buttons related to the exercise. Pressing the *model answer* button shows a model solution as a visualization with explanations similar to the learning mode. Assessment mode supports two different modes for feedback: *continuous* and *"on request"*. With continuous feedback, the exercise informs student immediately after each action if it was incorrect. As this can lead to a trial-and-error solving strategy, the "on request" mode only gives a student feedback when requested by pressing the *grade* button. In the on request feedback mode, the exercise cannot be continued after viewing the model solution. Furthermore, the *reset* button initializes the exercise with new random input. Finally, the *undo* button can be used to undo one operation.

The feedback in the "on request" mode is the number of steps the student solution has correct. The grading functionality in both modes is based on comparing the states in the student solution sequence and the model answer. This functionality is implemented in the JSAV algorithm visualization library (http://github.com/vkaravir/JSAV) used by our visualizations.

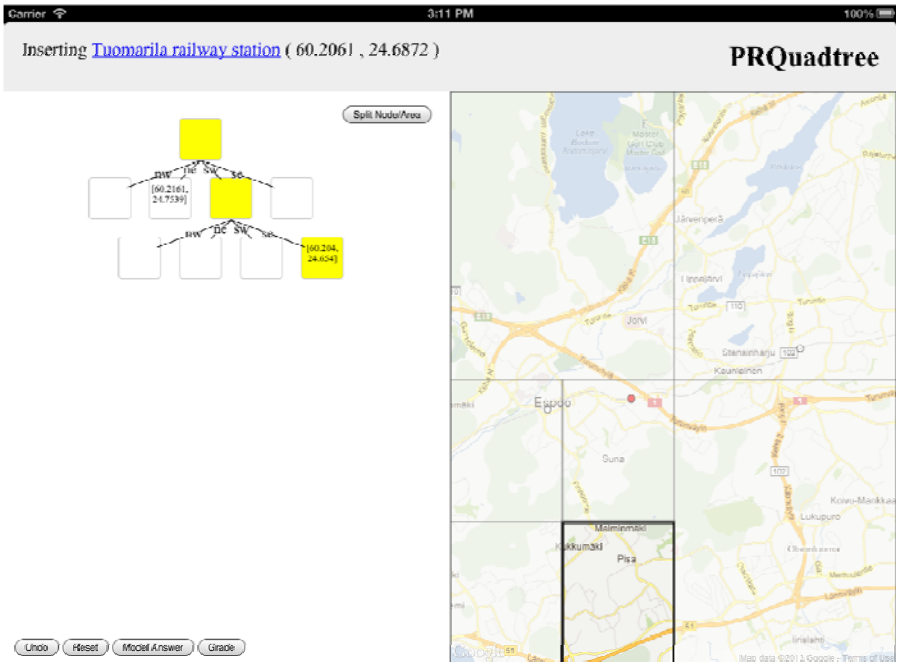

Figure 2. Example of the PR Quad-Tree in assessment mode on the iPad.

3.3 Technology

From the technical point of view, the visualizations are implemented with HTML and JavaScript. They use the W3C Geolocation API to get the users current location. Based on this location, semantic data is fetched from DBPedia, the semantic version of Wikipedia (Auer *et al.*, 2008). After processing the data, visualizations use the JSAV algorithm visualization framework to show the visualization or the exercises. JSAV also grades the student answer in the assessment mode by comparing the student-generated visualization to the model visualization. Showing the data on a map uses Google Maps. Furthermore, we have tested the visualizations in browsers of both iOS and Android 4.0, several desktop browsers, and as a native iOS application using PhoneGap (a framework intended for wrapping HTML and JavaScript as native applications).

4. DISCUSSION AND FUTURE WORK

We believe the new location-aware content presented in this paper is motivational and interesting for students. Alas, we have not used it in teaching with students yet. One reason for this is that we do not feel comfortable in using these as a required part of a course, since some students might not be willing to share their location. However, as previous research has shown, engaging algorithm visualizations can well be educationally effective.

We see the trend of mobile web technology use only increasing in the future with more focus given to interactive learning material that works across devices. While we want to be part of this trend, at the same time, we want to explore ways the new technologies can be used to provide better learning experiences in addition to converting existing material to new devices and platforms. Thus, in this ongoing work, we have taken first steps toward adapting algorithmic learning material to the location of the students as well as using authentic data in the exercises.

In the field of computer science education, new educational systems are often built with modern web technologies like HTML(5) and JavaScript. For example, Guo (2013) presents a visualization tool for the Python programming language that works on desktop and tablet devices. Karavirta *et al.* (2012) introduced MobileParsons, which is a mobile learning application for Python using web technologies. Galles has a large

collection of algorithm visualizations online (http://www.cs.usfca.edu/~galles/visualization/), all implemented with JavaScript. However, when it comes to selecting a library for creating new visualization and exercises, there is relatively little choice. The JSAV library we used is practically the only JavaScript library that supports algorithm visualization and automatic assessment of simulations of algorithms.

As the exercises are implemented with HTML and JavaScript, wrapping them as a native application with PhoneGap works well. We see distribution through official application stores like Apple App Store and Google Play as an important step in distributing educational applications. However, we do not have enough content yet to make it an independent application.

In the future, we will focus on creating content for more algorithms. Hopefully, this can be done in collaboration with the OpenDSA project (Shaffer *et al.,* 2011) and other teachers and researchers in the field. Furthermore, a fruitful addition could be to add a measurement of learner knowledge to our content. This would enable us to better contextualize the material, for example, by first offering the learning mode, then the assessment mode with continuous feedback, and finally ask the student to solve the exercise with on request feedback. Finally, only using the content in teaching will show whether the material actually is motivational and effective for students.

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LEARNING WITH SMARTPHONES: STUDENTS' LIVED EXPERIENCE OF USING SMARTPHONES

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ABSTRACT

With its wide-ranging applications and multiple features, the smartphone is propelling a new way of learning "on the fly". Mobile learning is more than simply learning with certain types of digital technologies: through everyday practices of using the smartphone, learning can take place in formal and informal settings and in the boundary spaces in between. In this study, an interpretive research design is used to understand how young people in Malaysia use their smartphones for learning and to uncover the meaning of their lived experience. Applying the principles and practices of hermeneutic phenomenology, this study aims to gain access to a phenomenon that is often subconscious and to interpret the participants' learning experiences. Twelve youths participated in three rounds of semi-structured interviews over a period of four months. Preliminary findings suggest that learning with smartphones is occurring more deeply and widely than perceived with participants having a nuanced view to the value of this learning.

KEYWORDS

Formal and Informal settings, Social-cultural contexts, Smartphone learning, hermeneutic phenomenology

1. INTRODUCTION

Smartphones are the more expensive versions of mobile phones and generally have multiple functions, serving as video recorders, camera phones and portable media players with high-resolution touchscreens. They run on mobile operating systems such as the Apple iOS, Google Android, and Nokia Symbian that can log on and accurately present standard web pages as opposed to only mobile-optimized sites. With its multiple applications and diverse features, the smartphone is propelling a new way of learning "on the fly". The nature of the present mobile learning environment however, is fragmented with many definitions of mobile learning. Generally, most definitions agree upon the importance of access, context and conversation (Sharples et al., 2007, Kukulska-Hulme, 2010, Hwang and Tsai, 2011).

The aim of this study is to discover from the learners' perspectives how they use mobile technologies to learn in their daily lives in relation to their historical and cultural contexts, and to uncover the meaning of this learning. A study of the lived learning experiences of the student participants in Malaysia with smartphones would be able to add to new knowledge as there appears to be a paucity of interpretive research in this area and the findings and conclusions could yield new understanding that may prove useful especially in its implications for formal and informal learning.

2. RESEARCH PHENOMENON AND RESEARCH QUESTIONS

Learning is a complex phenomenon and theories and conceptions of learning abound. The complexity is related to learners' cognitive processes and their interactions with society and culture (Gee, 2008). Learning is thus, multifaceted and context-dependent and at times, subconscious, automatic and unobservable (Pachler et al., 2010, Gee, 2008). In investigating the learning phenomenon, the main question in this study is 'What does it mean to learn with smartphones?' As this question includes numerous embedded and overlapping phenomena, which required further exploration, the following sub-questions were investigated:

- What is this experience of learning with smartphones like?
- How do the student participants perceive the nature of their learning with smartphones?
- Are they learning in different ways as compared with previous generations?

3. MOBILE LEARNING AND THEORIES OF LEARNING

The nature of the current mobile learning environment is divided with many definitions of mobile learning (m-learning) as the mobile learning community includes theorists and researchers with philosophical associations ranging from empiricists to post-structuralists. Naismith et al. (2004) use an activity-centred perspective to review mobile learning projects against the existing learning theories: behaviourism, constructivism, situated learning and collaborative learning. Cochrane (2008, p.1) notes that the use of mobile technologies for learning is underpinned by "newer learning theories that find their roots in social constructivism such as: authentic learning, communities of practice, distributed intelligence, distributed cognition, connectivism, and activity theory". The growing body of m-learning research is evidence of the increasing importance of this field with most studies concentrating on mobile system design, and effectiveness of m-learning (Traxler, 2010, Wu et al., 2012, Hwang and Tsai, 2011).

From the perspective of learning as knowledge creation, Sharples et al. (2007, p. 225) defines m-learning as "the processes of coming to know through conversations across multiple contexts". Pachler et al. (2010, p. 6) builds on this conception of m-learning by suggesting that learning occurs as "a process of meaning making though acts of conversation on the basis of a pre-given, objectified cultural world". This socio-cultural ecology of m-learning has the core constituents of agency, structures and cultural practices (Pachler et al., 2010). 'Structures' are the structures of technology and mass communication in everyday life such as schools, the Internet and leisure, and learners navigate within and between these structures and produce new structures through their mobile use. 'Agency' refers to the individual learner's ability to appropriate these structures for learning that is subjectively meaningful. 'Cultural practices' are the everyday practices and routines located in a society and culture that engender learning that is situated, reflexive and collaborative in knowledge building (Pachler et al., 2010). Learning thus, occurs as knowledge is co-created and skills and competencies are developed in these contexts (Lave and Wenger, 1991, Scardamalia and Bereiter, 2006, Pachler et al., 2010).

4. RESEARCH METHODOLOGYAND METHOD

A hermeneutic phenomenological approach was utilized as it is the most suitable to investigate the research questions and to explore the lived experience of learning with smartphones. Hermeneutic phenomenology explores the uniqueness of individuals' experiences with an emphasis on the individuals' historicality or background (Heidegger, 1962, Gadamer, 1997). It is the study of experience with its meanings. Hermeneutics enhances the interpretive element to illuminate assumptions and meanings in the text that participants themselves may have trouble expressing, hence providing a rich and dense description of the phenomenon under investigation (van Manen, 1997, Crotty, 1998).

As consistent with the interpretive research paradigm, participants were chosen using purposive sampling strategies to provide information rich studies for detailed analysis (Denzin and Lincoln, 2000). The 12 students chosen were 16-19 years and currently in secondary schools and private tertiary colleges. There is a deliberate mix of students from different educational backgrounds as Malaysian secondary schools presently bans the bringing of smartphones to schools, while private tertiary colleges allows their use in classrooms. There would be thus, a diversity of learning experiences in formal and informal settings. The other criteria for the sampling were based on race, gender (7 males, 5 females) and at least one year of experience with using smartphones.

The most extensively acknowledged method derived from hermeneutic phenomenological methodology is the qualitative interview (van Manen, 1997). It enables a deep investigation of the phenomenon: there is the exploration and collection of participants' stories told in their own words, and the development of a conversational relationship between the researcher and the participants regarding their lived experience (Ajjawi and Higgs, 2007). The choice of semi-structured interviews was to offer better scope or richness in

data compared with structured interviews, and enable participants choice to reply to questions and probes, and to narrate their experiences without being constrained to specific answers (Ajjawi and Higgs, 2007). Another benefit over unstructured interviews is the comparison of some standard questions across interviews.

In this study, it was determined that structured in-depth interviews with 12 individuals would meet the aim of an in-depth investigation. There were 3 rounds of interviews over a period of 4 months conducted until the point of saturation where no new ideas were surfacing. Each interview lasted from 1 to 1 hour 30 minutes and was recorded and transcribed verbatim. Permission for the interviews and recordings was sought from the participants and their parents, and transcripts and interpretations were made available to them to comment. This ensures accuracy of data analysis and interpretation to achieve better methodological rigour. The researcher was careful to maintain "hermeneutic alertness" (van Manen, 1997), which is the reflexivity required to reflect on situations and stories rather than accepting them at face value or imbuing them with pre-conceived suppositions. Field notes that were written down after the interviews were instrumental in recording the researcher's insights and reflections and a critical examination of the emerging issues.

5. ANALYSIS AND INTERPRETATION

As this is an interpretive hermeneutic phenomenological study, the analysis and interpretation of the interviews were guided by van Manen's (1997) methodical procedures. First, interview transcripts were read carefully and repeatedly for emerging themes: detailed reading at sentence or cluster level, then using the selective or highlighting approach and finally reading holistically. Second, as the researcher dialogued with the texts, themes and sub-themes emerged, and a coding frame was developed from the key words and concepts (van Manen, 1997). Third, interpretation of the themes and sub-themes was achieved through Gadamer's (1997) hermeneutic circle and the fusion of horizons. The hermeneutic circle refers to the interpretive process that moves from components of experience to the whole experience and back again and is repeated to enhance the depth of understanding and engagement with texts. The researcher's prejudice and presuppositions are acknowledged and considered as valuable in hermeneutic phenomenological research. In Gadamer's conceptualization, one horizon is the researcher's prejudice and the other is the subject on hand. The aim is for a fusion of horizons as the researcher dialogues with the texts to bring about understanding of the research phenomenon under inquiry (Gadamer, 1997). In this study, the researcher examined her prejudices in the field notes and continued with the examination in the analysis stage.

6. THEME 1–PARADOX OF INCREASING AND DIMINISHING VALUE

Several themes and sub-themes emerged and in this paper, 2 themes are discussed. Most research literature reveals positive outcomes and positive attitudes to m-learning (Wu et al., 2012). In this study, some of the student participants display a more nuanced view to their learning: it empowers and satisfies but it can be a "double edged" sword.

"I value the ability to know..like have..to have the Internet wherever I am, to learn anything every time I want, you know, so that curiosity, normally always satisfying…It allows me like before debates, if I'm nervous, if I don't know enough, I have the ability to read, the ability to browse through ten articles or something, so I like this idea of being able to know anything I want to know at any time, ya."

Ben, 17 yrs old, Form 5 student

"At times, learning on the go, sometimes you want answers to certain questions, it just is like wanting to know the answers for the sake of knowing the answers and nothing else… So certain things ..you tend to forget the answers and you've solved whatever you want to solve…..".

"…when you look at it, it actually..everyone is self learning and all that, but the general knowledge of certain youngsters today is very, very low and I feel maybe, it's because of this. Because they are being spoon fed with everything on the Internet. And they're not street smart. Their general knowledge is quite low, which is a very bad thing".

Deeptzer, 19 years old, private college student

Learning with smartphones has value because it enriches their lives and is highly prized as seen in Ben's quote. In comparison with their peers who do not have smartphones, being able to search for information and

learn new skills and knowledge gives them a head start in their lives. Yet this easy convenience and accessibility to learning anytime, anywhere can have diminishing value to learners. As Deeptzer suggests, when something becomes too easy, too available, its value diminishes as learning becomes eminently forgettable, and disposable like some of their lifestyle items. By the term, 'spoon fed', she thinks that with the easily available information at their finger tips, there could be the possibility of not sieving through the information and accepting information without questioning their sources. As a result, there are self satisfied learners who do very little critical thinking. Chuck, another participant is an avid reader of e-books on his smartphone and he spends up to 3-4 hours a day reading and searching for information. He is conscious of excessive use of his media and smartphones, calling it "double-edged" as "it's really useful for information, communicating back but if you harp on it too much, it can take over your entire life".

7. THEME 2- THE SUM IS MORE THAN ITS PARTS

From the everyday practices of the participants, the lived experience of learning appears to be situated, reflexive and collaborative in building knowledge (Lave and Wenger, 1991, Pachler et al., 2010). The learning experience was continual and cumulative with the participants reporting that they searched for information and read from between 30 minutes to 4 hours per day. Learning was not comprised of only searching for information, and reading or writing practices with the smartphones. Participants reported everyday practices of learning such as recording lectures, taking and editing photographs, social networking, learning languages, playing games and creating videos, music and ringtones. The misconceptions of their parents, some teachers and adults who perceived them as playing and wasting their time with their smartphones instead of reading and learning were refuted. Stevie, for example, gives her response to the continual and sub-conscious learning:

"We do read. Older generations tend to think if we're holding our phones, it means we're texting, we're not reading. What they don't know is that we might be reading through our smartphones. Just because you don't see it, doesn't mean that we don't (laughs)….(Reading estimate) I think it's a lot! I don't do it all at once but it accumulates. Per day...3-4 hours. Ya, ya! Cause we're unaware, we just take it, put it back, take it up again.

The participants may be learning more widely and deeply but the fundamental question is whether they are learning more effectively. Selwyn (2009, p. 368) argues that there are concerns with the "intellectual and academic "dumbing-down" associated with young people's digitally redefined relationships with information and knowledge" as they appear incapable of gathering information from the Internet in a discriminating mode. Keen (2007, p. 93) suggests that there is now a "younger generation of intellectual kleptomaniacs, who think their ability to cut and paste a well-phrased thought or opinion, makes it their own". These findings have implications as it suggests that young people may not be able to discriminate and construct knowledge critically in informal learning environments. However, from the participants' experiences, there were accounts of 'cutting and pasting', but they were all aware of the issue of plagiarism and most demonstrated sophisticated methods of gathering and synthesizing information. They deemed their learning to be effective as they perceived themselves as better learners as the learning with the smartphones helped them in their school subjects and enabled them to gain more general knowledge and skills.

8. CONCLUSION

As this research study is still in progress, the findings and conclusions are preliminary in nature. The everyday practices with smartphones that have been taken for granted by the participants reveal that situated, reflexive and collaborative learning is driven by the purpose and need of the learners. However, learning is oftentimes unconscious as the learners were more aware of their media use than of deriving learning from their everyday practices. Learning was continual, constant and cumulative as they built on their knowledge through their everyday practices with smartphones. However, while they are learning more deeply and widely, the question remains as to the effectiveness of this learning.

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INVESTIGATION OF USING ANALYTICS IN PROMOTING MOBILE LEARNING SUPPORT

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ABSTRACT

Learning analytics can promote pedagogically informed use of learner data, which can steer the progress of technology mediated learning across several learning contexts. This paper presents the application of analytics to a mobile learning solution and demonstrates how a pedagogical sense was inferred from the data. Further, this inference was used to identify undesirable learning behavior and estimate the effectiveness of the learning strategy.

KEYWORDS

Learning Analytics, Mobile Learning, Performance Support

1. INTRODUCTION

Learning Analytics is an evolving field that holds the promise of augmenting teaching and learning experiences through its data-driven approach, and often traces its roots in related domains like educational data mining, web analytics, semantic analysis and so on (Ferguson, 2012). Bienkowski et al., (2012) postulates that learning analytics deals with the interpretation of learner data to be able to assess the learner preferences, detect the progress along with embedded problems and predict the future performance. Thus, it involves data collection, measurement, analysis, reporting, and representation of mined data in a meaningful way such that both learners and trainers can make sense of the current state of learning and optimize the learning interventions (Bichsel, 2012). Alongside of this, researchers proclaim that analytics maximize the use of data by converting information into insight, thus supporting in strategic decision making, which can impact the overarching goal of increased learner engagement and enhancement (Macfadyen and Dawson (2012), Cooper (2012)).

With the increasing adoption of technology mediated learning, there is a higher scope to trace the learner trails and gather the data pertaining to learner, context, outcome, resources, actions and more (Verbert et al., 2012). In this pretext, Siemens and Gasevic (2012) note the value proposition drawn from the online data trails, which reflects learner engagement in social networks, fine grained learner behaviors in an online or mobile learning environment. This affordance of collecting learner traces to improve learning engagements is stronger and realistic in mobile medium than a computer-based learning environment. That is because mobile devices are ubiquitous, sensor enabled and always turned on, which attribute to an intensive tracking mechanism resulting in large and realistic data sets (Duval, 2012). Additionally, due to their characteristic ubiquitous nature, mobile devices augment the job performance effectively. In support of this notion, Udell (2012) mentions that performance support tools are accessible anywhere and anytime, enabling the employees work better in their jobs and hence emphasizes that mobile medium is a perfect channel to support the performance.

Despite a radically transforming ability towards pedagogy, there has been minimal evidence in identifying the right set of questions to mine the data or understand what data is required to arrive at certain thematic conclusions. In other words, the on-going research hasn't yet revealed an established method or methodology for learning analytics to inform the teaching and learning design (Dawson et al., 2008). Relating this idea to mobile learning, Aljohani and Davis (2012) highlight the limited research conducted about using mobile learners' data in sense making.

In the light of this research gap, this paper addresses the deficit by presenting a Mobile Learning Analytics case study. The paper introduces a mobile learning solution that aims to support on-the-job performance and demonstrates how analytics has helped identify trends and patterns, from mobile learner driven data. This analysis has helped accomplish one of the key objectives of Learning and Knowledge Analytics that is to spot the undesirable learning behavior (Verbert et al., 2012), which has resulted in detecting learners' performance gaps and estimating the effectiveness of the mobile learning app.

2. THE FRAMEWORK

The study begins by laying out a bottom-up framework for characterizing the nature of metrics available to mobile learning designers, and then recommends a possible strategy for future applications. For the sake of simplicity, we refer to a smartphone app ("app") as a prototypical mobile learning solution in the following narrative. The primary classification derived from the boundaries of the learner's interaction with an app yields two types of metrics: intrinsic and extrinsic. Intrinsic metrics pertain to the information collected from the point the learners launch the app to the point they close it. Extrinsic metrics pertain to the information that can relay insight into learners' ratings post-use of the app, what the learners were performing immediately before launching the app (hence triggering the need to seek learning), as well as what they intend to perform immediately after closing the app (which, in an ideal case, would be to apply or to employ the designed learning objective from their interaction in the app).

Furthermore, intrinsic metrics can be broken down in to subject-based, time-based and location-based metrics. Subject-based intrinsic metrics include data points that capture the identity of the learners and what they were interacting with in the app. Time-based metrics include data points that capture the time, duration, frequency and recentness of interactions, along with the span of idle-times. Lastly, Location-based metrics include data points that capture the geo-location, proximity to points of interest as well as the rate of change of learner's location. The points of interest can be deduced from locations that may lie on the learner's physical journey leading up to the actual engagement in the designed learning. For instance, if an app is designed to provide European competitor fact-sheets to a sales person, who is based in Chicago, IL (USA), and is traveling to France for a conference, then some key points of interest may be the home address, in-transit airports, conference location, and so on.

2.1 Drawing Analytical Insight from Intrinsic and Extrinsic Metrics

The classification above only gives us data points that can be captured using technology that is available to mobile devices via various programming interfaces. However, to draw analytical insight, it is essential to understand who interacts with the app and what the underlying context is. This resonates with the idea of Learner to Learning Material interaction, which is Learner to App in our context, that helps realize mobile learning analytics (Aljohani and Davis, 2012). This enables analysts to evaluate whether the level, frequency and nature of interaction result in designated learning objective.

The mobile device, be it a tablet or a smartphone, has a multitude of factors that define the context of the learner (such as battery and network strengths, social interruptions, distractions, to name a few), much beyond the scope of content and learning design. The possible combinations of the intrinsic and extrinsic metrics that allow us to gain real insight into the efficacy of a design are numerous, and often overwhelming..

As the following case study shall depict, the iterative method of analyzing metrics and drawing insights can assist in identifying the weak elements of content design that lowered the learner engagement along with revealing the gap in learner-app interaction strategy. The intrinsic metrics that the case study captured included item-level responses alongside the time and location markers of each interaction. We chose to not include any extrinsic metrics in the initial release of the app, to allow us to focus on how content and instructional design factored into the learning design.

2.2 Case Study

In 2010, we designed an iPad app that allowed managers to collect customer needs by answering a certain set of questions. The intention was that managers would launch the application, create a new "customer session"

or open an existing one. Next, they would see a set of multiple choice, text entry, and slider questions that would guide them in filling out a mobile form. Initial conversations and requirements gathering from potential users of the app allowed us to incorporate key features that accommodated the context of the end-user. For instance, the managers identified that the app may be used in locations that may have spotty network connectivity, which required us to feature a sync-capability to record data local to the device and then merging with a central record store. Another feature accommodating the manager's contextual needs included a shared analysis dashboard that allowed comparing client results with other managers of the same organization. As for the content, the order and nature of the questions were a linear, scrollable list of questions in a predetermined order, based on expert advice and recommendations.

The learning objective was to help the manager gather the customer requirements in a holistic manner, so that they can relay the information down to development teams as well as use it in future interactions/engagements. In this process, the metrics about user behavior as well app-states (intrinsic, in nature) were tracked to identify the gaps between what was expected (as outlined by their needs) and what was observed (actual context-defined behaviors). To track these metrics, we created a native app (written in the Obj-C programming language) that interacted via an event and value analytics interface with a custom Google Analytics instance. The metrics collected were analyzed using a combination of the reporting available from Google Analytics as well as Microsoft Excel data tools. Table 1 depicts the intent and detailed metrics, as per the first rollout of the app.

Table 1. Intrinsic metrics captured in the initial rollout of the app

Interaction	Observation Intent	Metrics
Questions	Design effectiveness	Duration, Time, Frequency
Dashboard Access	Design and behavior	Order of access, Time, Frequency (per session)
Session Interaction	Contextual user behavior	Duration, Time, Number of Questions completed

Based on these metrics, few vital performance problems were detected that resulted due to deviation from the expected learner behavior in using the mobile app. Given the limited scope, this paper introduces 3 different scenarios that were analyzed in the context of metrics and presents the insights drawn along with the indicative corrective measures. The data revealed some key findings.

First, we expected that the customer "sessions" would depict a high level of completion of the survey (more than 90% of questions answered). Instead, the customer "sessions" were often started during business hours, left incomplete (more than 20% questions unanswered) by the managers, while averaging the same total duration with very little variance. This most likely indicated that the managers were using the app during conversations with their customers, while following the question content, but the structure and order of the questions may not have assisted in actual data entry. These metrics were used to iterate and refine the design of the questionnaire.

Second, we didn't expect to see any patterns in what type of questions were answered. However, our metrics revealed that the slider type of questions was consistently left unanswered. Additionally, the slider questions that were answered had an unusually prolonged duration of interaction (user sliding the slider knob for a long time). This indicated that the design of the actual interaction (sliding knob of slider) demanded us to look at alternatives. Could it be that the manager wasn't able to use the slider question effectively on the iPad? The iteration around this metric was to alter the actual design of the slider question in an aim to drive a higher answer count and considerably less interaction time. The alternate design that helped us meet these revised expectations is depicted in Figure 1.

Figure 1. Altering design of the slider question type to allow hints

Third, the manager most frequently switched between the customer sessions and the dashboard, rather than spending prolonged times between accessing the two views. In this case, we could draw insight that the learner behavior within the context of recording customer responses involved going back and forth between the questions and the summary dashboard. This potentially required us to redesign how the dashboard was not a separate element, but instead needed to provide a level of performance support to the survey functionality of the questions. The revised dashboard was accessible as a popup from the questions, rather than a distracting view separated from the question interface. This is an example of a metric that allowed us to draw insight into how the manager was using the app as a performance support tool during a conversational context.

3. CONCLUSION

As the case study has depicted, the iterative method of analyzing metrics and drawing insights can support in (a) comprehensively identifying the attributes of the content design that may result in low engagement of the mobile learner; and, (b) falsifying assumptions around mobile design that may have originally led to less effective learning solutions. Thus, analytics has enabled an early detection of undesired behavior in job performance and as well provided a "before and after" snapshot of learner interactions after changing the learning activity design. With increased metrics, this analysis can be taken to the next level of monitoring the learner behavior, to identify the precise points of disconnection for every single learner and perhaps adapt the design and complexity of questions accordingly. Based on this, we propose an iterative 3-step approach – hypothesizing, tabulating and abstracting towards using analytics in mobile learning.

Let's consider an iPad application that provides help content to culinary students. One hypothesis may be to question the effectiveness of the 10-minute videos that are used in the application. Next, we tabulate metrics that may relate to students' engagement with the video content. For example, let's consider the learners' durations for and frequencies of watching each video, the original length and the targeted objective of each video, and the times between consecutive accesses of each video. Lastly, we shift the level of abstraction so we can group items to observe learner trends relating to the nature of the video shown (e.g. videos about cooking v/s videos about preparation). If we find that a certain video category (e.g. preparation videos) is least watched, both in frequency and duration, the efficacy of video as a means of conveying that information may not be most efficient. At this point, we iterate our analysis by reframing a new hypothesis around the category of videos that reveal this behavior (i.e. preparation videos in our example). New tabulations may include metrics like learner ratings. However, limiting analytics to learner ratings may only capture learner perception of value, rather than how well the learning design is aligned to the learner's context.

Drawing on the approach, this paper concludes by posing an evolving framework for mobile learning analytics which observes mediation between a) learner interactions (learner-device and learner-material) and b) intrinsic and extrinsic metrics, which undergoes an iterative analysis to translate information into insight (Figure 2).

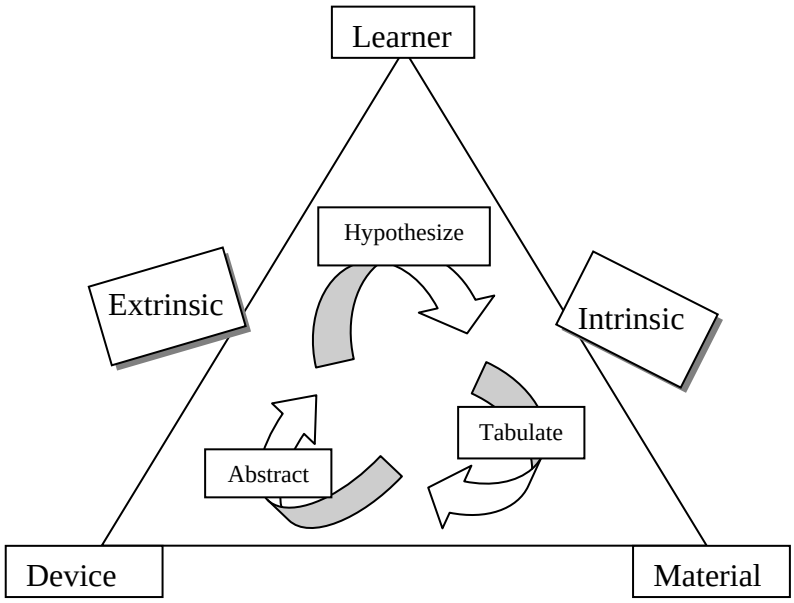

Figure 2. Iterative analytics framework

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TABLET USE WITHIN MEDICINE

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ABSTRACT

This paper discusses the scholarly literature related to tablet computer use in medicine. Forty-four research-based articles were examined for emerging categories and themes. The most studied uses for tablet computers include: patients using tablets to complete diagnostic survey instruments, medical professionals using tablet computers to view radiology results in order to make a diagnosis or share results with patients at the bedside, and surgeons using tablet computers to view and manipulate patient specific three dimensional images during surgery. In addition, educational uses of tablet computers included: tablets to support patient education and medical residents using tablets as portable computers in clinical settings. These uses indicate that within medicine, tablet computers are being used for more than just providing convenient anytime anywhere access to reference material.

KEYWORDS

iPad, tablet computer, medical education

1. INTRODUCTION

There have been many announcements regarding the use of the current generation of tablets, such as Apple's iPad, by students at medical schools; for example, Stanford School of Medicine (White, 2010) and Yale School of Medicine (Dodson, 2011). The primary purpose of these initiatives is to reduce the amount of paper curriculum materials by providing digital versions of textbooks and other curriculum documents. However, the use of tablets in medicine goes beyond providing easy access to reference materials and replacing textbooks. In this paper, the author examines the scholarly literature to determine how tablets are being used in medicine and medical education.

2. METHODOLOGY

The US National Library of Medicine National Institutes of Health database, PubMed (http://www.ncbi.nlm.nih.gov/pubmed), was searched on November 3, 2012 for "iPad" or "tablet computer" for articles published after January 1, 2011. The current generation of tablets were launched with Apple's release of the first generation iPad in March 2010. Articles regarding tablet computers published prior to January 1, 2011 represent opinions about the potential of the technology or refer to the older generation of tablet technology such as the Tablet PC, and as such, were excluded from this literature review. The search resulted in 92 articles. Articles not relating to tablet technology were excluded (e.g. articles relating to the ipaD gene function) leaving 65 articles to be reviewed. Of these articles, 21 were not research-based articles, such as: advertisements, lists of apps, commentary, or editorial. The remaining 44 research-based articles were reviewed for emerging categories and themes.

3. RESULTS AND DISCUSSION

Two methods of categorization emerged from the review: (1) how the tablet computers were used in the study (i.e. reference/patient education, data collection/diagnostic, or treatment), and (2) who used the devices in the study (i.e. patient, medical professional, or medical educator/student). Four articles did not fit within

the classification system. Table 1 illustrates the number of articles in each category. The results help to highlight that medical educator and student tablet use focuses on providing easy access to reference material, where as medical professional use of tablets focuses on collection of patient data, diagnostics, and treatment.

Table 1. Summary of number of articles in each category.

	Reference/ Patient education	Data Collection/ Diagnostic	Treatment	Total
Patient	★★★★★ 5	★★★★★ ★★ 7	★★★★ 4	**16**
Medical professional	★★ 2	★★★★★ ★★★★ 9	★★★★★ 5	**16**
Medical educator/ Student	★★★★★ 5	★★ 2	★ 1	**8**
Total	**12**	**18**	**10**	

3.1 Studied Uses for Tablets in Medicine

The most studied uses for tablets include: patients using tablets to complete diagnostic survey instruments (n=7), medical professionals using tablet computers to view radiology results in order to make a diagnosis or share results with patients at the bedside (n=7), and surgeons using tablet computers to view and manipulate patient specific three dimensional images during surgery (n=4). In addition, educational uses of tablet computers included: tablets to support patient education (n=5) and medical residents using tablets as portable computers in clinical settings (n=3). A description of each of these uses follows.

3.1.1 Patient Use of Tablets to Complete Diagnostic Surveys

Several studies involved the use of tablet computers as a mechanism for patients to complete diagnostic surveys (Holzinger et al., 2011; Harrington et al., 2012; Tomori et al., 2012). Rather than asking the patients to complete a paper survey, patients are asked to complete an electronic version of the survey using a tablet. Upon submission, the survey results are automatically stored in the patients' electronic medical record making them immediately available to medical professionals. The benefits to this approach include: (1) immediate calculation of results allowing for faster diagnosis and treatment, (2) more accurate medical records as transcription errors are reduced, and (3) cost savings due to a reduction in printing and the labour associated with transcription. In addition, patients have indicated a preference for the electronic forms (Fritz et al., 2011). Furthermore, the flexibility of the electronic medium allows for surveys in multiple languages, and surveys based upon images for patients with low-literacy levels (Ahmad et al., 2012; Ruamviboonsuk et al., 2012).

3.1.2 Medical Profession Use of Tablets to View Radiology Results

Initial consumer focus has been around tablets as consumption devices, i.e. computers that are used to access content anytime and anywhere. From a medical professional perspective, this translated into a physician's ability to access patient medical records and lab reports from anywhere: for example, an on-call radiologist using an iPad to complete an emergency diagnosis (John et al., 2012). As a result, there have been several tablet research studies involving testing the effectiveness of tablets as tools to view radiology reports for making diagnostic decisions (Christopher et al., 2012; Johnson et al., 2012; Shintaku et al., 2012). The studies compared the diagnostic results between LCD monitors and Apple iPad 2 tablets. In all but one case, the result was 'no significant difference' between the LCD monitor and Apple iPad 2. The one exception was when iPad 2 tablets were used in emergency computed tomography (CT) brain examinations where "the iPad display performed inferiorly to the diagnostic monochrome display" (Mc Laughlin et al., 2012, p.127). This points out the need for additional experimentation and testing leading to guidelines regarding appropriate uses for tablets as tools to support diagnostics.

3.1.3 Surgeons Use of Tablets during Surgery

An example of the use of tablets to support treatment in medicine involves the use of iPads in surgery. iPads have proven to be convenient, easy-to-use devices with long battery life, that surgeons can interact with directly while in surgery. The iPad is placed in sterile plastic bag or wrapped using sterile dressing, for example the use of 3M™ Tegaderm™ transparent film dressing to wrap the iPad (Murphy, 2012). The surgeons are then able to access and manipulate the touch screen without the need to remove their gloves. For example, a report by neurosurgeons describes how the iPad can be used to provide the surgeon with access to patient images without the need to leave the operation field. They concluded that accessing "imaging data with sterile gloves on the touch display was more convenient, more precise, and faster compared with other modalities" (Soehngen et al., 2012, p.381). Another example of the innovative use of iPads by surgeons is the use of the iPad camera to superimpose a picture of the patient on the operating table with three dimensional CT images of the patient taken pre-operatively in order to allow the surgeon to better visualize the location of tumors during laparoscopic surgery, that is surgery that is done through a scope without direct view of the tumor (Rassweiler et al., 2012).

3.1.4 Tablet Application to Support Patient Education

Tablets have been used to improve patient education. One study relating to cosmetic surgery involved showing patients several pictures demonstrating the possible outcomes of the surgery, both positive and negative. This led to increased patient satisfaction (Wang et al., 2012). In addition, there have also been studies where specialized mobile applications are developed to support public health initiatives such as food safety (Albrecht et al., 2012) and the effects of dietary sugar on dental caries in young children (Levine et al., 2012).

3.1.5 Student and Resident Use of Tablets to Support Clinical Learning

With the introduction of tablets at some medical schools, e.g. Yale University Medical School and Stanford University Medical School, and the requirement of students to purchase tablets at other schools, e.g. Brown Medical School (Husain, 2011); studies illustrating the uses and benefits of tablets in clinical learning and clinical teaching are emerging. A study of internal medicine residents at the University of Chicago demonstrated that residents' use of tablets "was associated with improvements in both perceived and actual resident efficiency" (Patel et al., 2012, p. 437), specifically that residents were able to order labs and provide patient education faster with the tablets than without them. In addition, a short article describes Junior Plastic Surgeon’s use of tablets to upload photographs of the treatment area of patients, which is then modified with photo editing software to help visualize the different treatment options and plan surgeries (Sadri et al., 2012). These reports are encouraging, as they indicate a possible transition from the tablet as a multimedia enhanced textbook, to the iPad as a tool to improve resident education and patient care.

Although medical schools are requiring the use of tablets, there were only two studies indicating the effectiveness of tablets in undergraduate medical education, specifically: (1) the use of tablet-based resources to support dissection activities in anatomy classes (Mayfield et al., 2012), and (2) the use of images on tablets to teach digital pathology in low-resource countries (Fontelo et al., 2012). The widespread use of tablets in medical schools provides an unmet opportunity for further exploration into how tablets can be used to improve medical education.

4. CONCLUSION

As the current generation of tablet technology is not yet three years old, there have only been a small number of studies into the use of tablets within medicine or clinical teaching. As a result, there is only anecdotal evidence to suggest that the use of tablets in medicine or clinical teaching is beneficial. However, the research-based studies examined in this paper suggest that tablet use within medicine is evolving beyond the device as a convenient anytime anywhere method for accessing reference material, to a device that is used to collect patient data, assist with patient diagnosis, assist with patient treatment, and support teaching and learning within a clinical setting.

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BENEFITS AND FINANCIAL IMPACTS OF ADOPTING TECHNOLOGY IN LEARNING

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ABSTRACT

This paper summarizes the results of an analysis of the impacts of adopting information and communication technology (ICT) solutions in a learning context. The analysis is based on a literature survey of articles reporting research cases studying the impact of adopting ICT based solutions in various learning contexts. The subject has been reviewed using the term blended learning that can incorporate both e-learning and m-learning approaches, as the boundaries between the various ICT solutions have become increasingly blurred. The focus of the study is on adult learning contexts. The contribution of this paper is to summarize how researchers evaluate and show the impact of adopting ICT in learning, and what the critical factors contributing to the success of ICT based solutions in learning are.

KEYWORDS

Impact analysis, adopting ICT in learning, ICT supported learning, blended learning, workplace learning

1. INTRODUCTION

During the recent years, there has been a lot of public debate on adopting information and communication technology (ICT) in learning. Big ICT companies, such as IBM, Apple and Microsoft, have launched initiatives aiming at bringing ICT to schools, universities and other learning contexts. The education system is investing money and effort on providing teachers and learners with digital content, communication devices and digitally enhanced learning environments.

The adoption of ICT based solutions for learning is not simple. Technical devices require investments, and they can become obsolete quickly. Developing digital content and changing teaching, learning and management practices takes time and resources. In this paper, we aim to explore how the current body of research knowledge supports decision makers in getting information on the impact of ICT based solutions on learning. We will contribute to this through exploring the following questions through a literature survey:

- How do researchers evaluate the impact of adopting ICT in learning?
- According to studies, what kinds of factors contribute to the impact of ICT based solutions in learning?

In order to conduct the search for material related to the study, it was necessary to define the terminology. The following definitions will be used in this article: ***Blended learning*** is used to describe learning systems that combine traditional face-to-face instruction with computer-mediated instruction (Graham, 2006). ***E-learning*** is instruction that is delivered on a digital device such as a computer or a mobile device (e.g. mobile phone or tablet) whose purpose is to support learning (Clark & Mayer, 2008). ***M-learning*** has to provide the means to study and learn anywhere and at any given time, using a mobile device, and with no permanent physical connection to a network (Gregoriev et al., 2004).

Using the definitions above it can be seen that e-learning is often used as a general term. We can conclude that m-learning can be part of e-learning, and blended learning can incorporate m-learning and e-learning approaches. For the purpose of this study, and in this article, the term blended learning is used, because it encompasses the necessary elements.

2. METHODS AND MATERIAL

We collected research material through the means of a literature review (Webster & Watson, 2002). The focus was on articles written after the year 2000. The articles were collected mostly through searches in Google Scholar and subsequent electronic journals and databases, looking for articles combining one of the following terms: *elearning*, *e-learning*, *blended learning*, *technology enhanced learning*, *mobile learning*, *mlearning* or *m-learning* with *impact*, *case study*, or *field trial*. The study progressed through the reference lists of relevant articles.

The analysis revealed that there was a dearth of scholarly articles offering solid facts and figures about the Return of Investment (ROI) of e-learning solutions in workplace settings. It was easier to uncover articles and case studies about e-learning or blended learning experiments in higher education. Even in these cases, the focus was usually on the learning outcome or participant (student or instructor) satisfaction.

Material assembled for this study includes also articles highlighting benefits of blended learning solutions other than cost savings. As the financial impact is often difficult to measure – and because it is not always straightforward, as savings can result from a multitude of factors – it is important to look also at the other perceived advantages blended learning has to offer.

3. BENEFITS OF BLENDED LEARNING

According to Osguthorpe & Graham (2003), the main goals for instructors designing blended learning environments are pedagogical richness, access to knowledge, social interaction, personal agency, cost effectiveness and ease of revision. In other words, these are the main characteristics that a successful blended learning system should have.

Bersin (2004) states that in the early stages of e-learning many programs failed. One of the reasons was that it was too easy to disengage, as there was no class to go to and no time set aside for learning–it is difficult to include an extra part into an already very busy day. The solution is a blended learning program and finding the right blend.

Snipes (2010) also reminds that there is not just the one right solution, and much of the success of blended learning is attributed to putting the building blocks of a company's learning content together so that the combination results in a highly engaging learning environment. Real learning does not come from a one-time training event; it requires a longer learning process. In order to really impact the learners, the experience needs to be engaging and personal. The goal is a long-lasting business impact, not just a transient effect.

To get the most out of an e-learning or blended learning solution, it is best to use an IT architecture that supports targeting and personalization. Thus, training efforts can be directed at the employees and competencies that have the biggest need for learning and knowledge. (Ley & Ulbrich, 2002)

Table 1 summarizes the benefits of blended or mobile learning reported by researchers. The studies that are based on the expectations of the studied group are marked in italics; the rest of the articles are based on case studies and field trials.

Table 1. Main benefits of blended learning

Benefit	**Mentioned by**
Ability to return to material and revise	Şahin (2010b); *Schooley (2009)*
Adaptability, tailoring	*Beutner & Pechuel (2012);* Quentin-Baxter et al. (2008
Better student performance	Bonk et al. (2002); Quentin-Baxter et al. (2008); Şahin (2010a); Sancho et al. (2009); *Singh (2003)*
Cost effectiveness	*Bastiaens & Martens (2000); Beutner & Pechuel (2012);* Bollinger et al. (2011); Brennan (2004); Cohen & Nachmias (2009); Kim et al. (2008); Kim et al. (2009); Quentin-Baxter et al. (2008); *Schooley (2009); Singh (2003)*
Expanding access to training	*Bastiaens & Martens (2000);* Bollinger et al. (2011); *Singh (2003)*
Immediacy, access just-in-time or in context	*Bastiaens & Martens (2000); Beutner & Pechuel (2012);* Bollinger et al. (2011); Bonk et al. (2002); Şahin (2010b)
Immediate feedback; interaction	Bonk et al. (2002); *Singh (2003)*

Improved collaboration and teamwork	Bonk et al. (2002); Şahin (2010b); Sancho et al. (2009
Improved learning or instruction	Bollinger et al. (2011); Cohen & Nachmias (2009); Kim et al. (2008); Kim et al. (2009); Quentin-Baxter et al. (2008); *Singh (2003)*
Increased motivation; reduction of absences or drop-out rates	Cohen & Nachmias (2009); Quentin-Baxter et al. (2008); Şahin (2010b); *Singh (2003)*
Independence of location and time, flexibility, convenience	*Bastiaens & Martens (2000); Beutner & Pechuel (2012);* Bollinger et al. (2011); Bonk et al. (2002); Brennan (2004); Kim et al. (2008); Kim et al. (2009); Şahin (2010b); *Schooley (2009)*
Influence on organization: development, productivity, recruitment, competence	*Bastiaens & Martens (2000);* Cohen & Nachmias (2009); Kim et al. (2008); *Leary & Berge (2007);* Quentin-Baxter et al. (2008); *Schooley (2009)*
More active students	Bollinger et al. (2011); Bonk et al. (2002); Şahin (2010b); Sancho et al. (2009)
Repeatability and consistency	Bollinger et al. (2011); Bonk et al. (2002); *Schooley (2009)*
Time savings; better use of time	*Beutner & Pechuel (2012); Leary & Berge (2007); Singh (2003)*

Several trends emerge in the studies. Freedom from the limitations of time and place is appreciated as well as the possibility to learn "just-in-time" when the information is needed, possibly in context. Blended learning also offers the possibility to tailor and personalize the learning experience. Cost-effectiveness is another key factor, and it comes through both savings and improved processes. Blended learning is seen to be motivating for the student, and often results in better retention, quicker learning and improved results. Communication and interaction are improved, and students feel less self-conscious about asking questions or having to reread the material several times than they would in a traditional classroom situation.

4. FINANCIAL IMPACT OF BLENDED LEARNING PROGRAMS

Finding specific company cases proved to be difficult, probably because their sensitive nature makes companies reluctant to share them. Some companies do not even measure the impact their learning solutions have; in a study by Bonk (2002), nearly 60 % of the respondents' companies had not completed a formal evaluation of the impact of Web-based learning. Of the companies that had measured the impact, 30 % had done an analysis such as the ROI calculation and 47 % had analysed the improvement in job performance.

Wenger & Ferguson (2006) write that initial investments in the infrastructure in blended learning are high, but after the investments have been made, the cost per student tends to be lower. The cost of content is high as well, but after a while the increased multipurpose use lowers the cost for additional applications.

Bersin (2004) points out that one should not roll out an e-learning or blended learning program just to save costs. The initial investments of e-learning solutions are usually quite high, comprising of infrastructure, content development and technology upgrades among other things. Also, savings can be a one-off thing, and a company cannot expect to continue on saving money on a yearly basis. According to Bersin, one should not measure the ROI of a training program based on how much money the company has saved. Instead, the focus should be on the improved skills that bring about new savings. Bersin states that if one increases productivity by one percent, it has over 10 times the financial impact of a one percent decrease in training costs. For companies wanting to save money, it is very important to focus on developing a purposeful, thought-out blended learning program – otherwise the initial costs will far outweigh the potential savings.

Microsoft has published some figures of learning examples with Microsoft learning products. According to their case studies, blended solutions helped to lower the costs of training, citing reduction figures of 30 % in one case. In the case of Microsoft de Argentina, the blended solution cost "a fraction" of the corresponding face-to-face training. (Ziob & Mosher, 2006)

At Avaya, a blended learning program helped salespersons perform better and increase the close rate, broaden the selection of products sold, increase the return on sales, reduce discounting and shorten the sales cycle. For the first six months after the learning program, the company reported over $36.3 million in incremental revenue with a 46.1 % ROI. (Chute et al., 2006)

Lewis & Orton (2006) reported an ROI of 17 to 1 for a learning program at IBM. Their calculations are based on the total costs for the creation and deployment of a management training module and the tangible cost benefits based on the use over 18 months. In addition to the cost savings, graduates of the program were asked to assess the direct financial first-year annual impact that the leadership training had on their

department. The average value given was $415,000, which gives an ROI figure of 47 to 1. IBM has also noticed that giving employees meaningful opportunities to learn and develop their skills means that they are less likely to leave the company in the first three years after they have been hired (DeViney & Lewis, 2006). As hiring and training new employees is expensive, improved employee retention can save a lot of money.

Similar findings are reported in Worthen's article (2001); the relatively high initial training investment of a company paid off because turnover was reduced through employee satisfaction. At GE, an ROI calculation on an orientation course revealed that employees could master the contents of the course in only three hours when studying online, whereas the onsite course had taken three days – and those three days required attendants to be flown to an offsite training facility. In this case, a lot of money was saved, especially since the training facility would have needed to be upgraded, causing an additional cost of $4.5 million.

Schooley (2009) reminds that technologically enhanced learning environments are cost-effective once the technology is in place and the company culture is adjusted so that these new learning patterns are embraced. Relying too much on financial justification may endanger the effectiveness of the learning program. Self-paced e-learning programs may enable learners to assimilate material often much faster than in a traditional classroom.

Forrester have calculated the ROI for a hypothetical North American insurance company with 5,000 employees (Schooley 2009). According to their calculations, the implementation of an e-learning program would generate an estimated 69 % ROI over three years. The figures depend on how well the company succeeds in supporting their employees in the change. In the Forrester example, the company would invest heavily to implement the e-learning program. The expected benefits exceed the costs, however, because savings can be gained from faster competency, training flexibility and consistency, and travel expenses. The Forrester model estimates that the investment will have paid itself back in 12 months.

Kapp & Vasta (2003) have written about the methods for calculating a performance-based ROI. They also stress that many factors need to be taken into account to fully evaluate the financial impact of an e-learning initiative. Although e.g. travel expenses can be cut and savings made, they do not really constitute an ROI and focus on the company's main concern – the need for education. To really convince a company of a good return on their investment, it is necessary to show how their blended learning contribution will benefit the company financially in the long run. Benefit types include improved employee productivity, improved quality of work and improved customer satisfaction.

Bollinger et al. (2011) have a case study on a HIV care course in Zambia. In their study, the online course initially cost $1,204 per student, but subsequent sessions were reduced to $171 per student, as the material was ready. The result was that the cost per student was significantly lower than that of comparable courses. In resource-limited and remote areas, distance learning programs are also less expensive to deploy.

Singh (2003) concludes that while producing a Web-based self-paced and rich learning environment might be expensive to deploy, it could be just as effective to create a more affordable blend using generic off-the-shelf products, recorded events, case studies etc. It is not always a question of how fancy the system is, rather than whether it fits its purpose. In many cases, simpler solutions will do and thus enable savings.

Beutner and Pechuel (2012) studied the acceptance of m-learning in German companies. Their study showed that many people were concerned about the costs involved with the technology and could rarely see any real potential to make savings when compared to the current education budget. To make m-learning more acceptable and attractive in companies, it would have to be seen as a money saving solution.

Cohen & Nachmias (2009) developed a cost-effectiveness model for Web-supported instruction that has been implemented at Tel Aviv University. The model uses data on how students and faculty use the Web, gathered from Web logs. The model provides information on the advantages that result from the improvement of the teaching process, not just financial benefits. An analysis of all the courses at the university revealed that a few courses managed to gather a significant part of the student benefits. This confirms that blended or e-learning is a highly context-sensitive method and cannot guarantee equal results in every case, even in the same university.

Brennan (2004) writes that it is difficult to clearly show a cause-and-effect relationship between training and performance, since it depends on so many different factors. It is also not possible to affect all areas of business improvement with just training. Many participants in Brennan's study had difficulty in ascertaining the benefits of their blended learning programs through a ROI or cost-benefit analysis. Isolating the effects of training and finding all the necessary information is challenging, which makes doing the calculations harder.

Leary & Berge (2007) write about the challenges smaller companies might face when considering e-learning solutions. Small organizations might not have personnel, whose (sole) responsibility is to be in

charge of employee learning and training, but focus is needed to build a successful blended learning program. Small companies find it hard to justify the sometimes high initial investment costs of e-learning, since the economies of scale do not apply to them, and the staff might have very different needs when it comes to training. According to Leary and Berge, the solution is to have a good strategy, one good training professional and, importantly, to start small. Even smaller companies can benefit from blended learning, and even a small effort can create a favourable outcome, if it is executed well.

There is a growing trend in workplace learning to measure the impact of blended learning by evaluating the increase in learner skills. A study by Kim et al. (2009) revealed that their survey respondents predicted a trend toward assessing the impact of blended learning at a higher level. This would mean that the quality of blended learning would also be analysed through its benefits to the company using tools like ROI or cost-benefit analysis. (Kim et al., 2008; Kim et al., 2009)

5. CONCLUSIONS

The results of this literature study show that blended learning can offer many benefits for companies looking to diversify their learning portfolio. Blended learning enables learners to study whenever and wherever it suits their needs, often just when they need a particular piece of information. Blended learning also offers the possibility to review and repeat learning modules and possibly feel less self-conscious about doing so or asking questions. In an optimal case, the learning material is tailored, learners are motivated and the result is a more efficient and capable employee for the company. Increased employee performance can in the long run also lead to significant cost savings.

In many cases, cost reductions can be the reason why a blended learning program is launched. In a simplified case, its reason for being is to eliminate costs related to travel, lodging and instructor time. These expectations can, however, lead to a huge disappointment. In order to build a successful blended learning program, substantial initial investments in technology are required. Also, careful work and planning goes into creating the right blend and relevant material. The material and the technology need to be updated regularly. This is by no means inexpensive, so it is important not to get blinded by the possibility of immediate cost savings. On the other hand, it is possible to benefit financially if the learning program is well-designed and will eventually lead to improvements in employee productivity or money-saving changes in organizational culture. Success depends largely on user acceptance and motivation and finding the right blend. Even if the result does not produce huge cost reductions, other benefits might still make it worthwhile.

M-learning solutions have gradually become notable elements of many blended learning programs. Therefore the impact analyses carried out in the field of blended learning are relevant also for the m-learning research community. Use of the same terminology and measures enhances the collaboration between the research fields and makes it easier to develop the right blend based on diverse approaches. In addition, when proceeding with the m-learning solutions from piloting to commercialization, it is increasingly important to be able to present measurable benefits. The models developed for assessing the impacts of the blended learning programs could be useful for that purpose.

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M-LEARNING FOR QUR'AN MEMORIZATION AND TEACHING ITS SCIENCES

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ABSTRACT

Providing a Conversional, Animated Qur'an Memorizer on modern smart phones will allow young generation technology savvies to be able to immerse themselves inside Qur'an and its sciences. Using technological means to deal with Qur'an and its sciences is at the focus of attention of the Noor Center in Taibah University. In this project we use the technologies of virtual reality, conversional interfaces, animated touch screens, metro-style navigation to build a Qur'an memorizer along with some of the Qur'an related sciences. The goal is to bring these technology attractions to Qur'an and it sciences. In this paper we present a small scale implementation of only Part 30 "جزء عم" of the Conversional, Animated Qur'an Memorizer application. The implementation is ported on major smart phones currently available and tested.

KEYWORDS

Conversional Interface, Virtual Reality, Animation, Metro-Style Navigation

1. INTRODUCTION

Have you ever wondered what would happen if we interact with the Qur'an the same way as we are interacting with our modern mobile iphone's Siri (e.g. conversional interface)? What if our mobiles help us memorize Qur'an any time anywhere? What if relevant Qur'an versus are attached automatically for us while text messaging? What if we have voice recognition Siri-like App for Qur'an indexing and search? What if we have instant audio Tafseer of Qur'an versus on our mobiles? What if we have mobile audio recitation of Qur'an with most of the ten recitations? What if we could use our mobile to correct our recitation of Qur'an ? What if our mobile keeps track (a counter) of the number of versus we memorize in each Sourah? As Siri can look for businesses, maps and traffic instant information (personal assistant), what if we have a Siri-like that can "Google Earth" our Qur'an - i.e. can visualize its structure (3D?) and be able to zoom in and out, link, associate, and correlate. Simply make us feel immersed inside the Holy Qur'an panorama. The current project will tackle some of the above capabilities as seed for the full capabilities as intended. The suggested Qur'an Voice Memorizer is intended to help end-users memorize recitation of the Holy Qur'an in seven ways, known as Al-Chatibiah's seven methods for reciting the Holy Qur'an . The key objective of the App is to allow the end-user to setup the narrator, the number of times to repeat each versus, and allow the end-user to record himself, and replay. After memorizing the whole Sourah, the end-user can move to checking mode where the App can listen and correct for him. Audi photonic search is a search capability of the App. It uses a database of photonics for Saudi speakers (50% female, and different age groups), and several audio templates (sound fingerprints and sound banks). Qur'an versus and their tasfssers are indexed for easy retrieval. In this paper we demonstrate feasibility over a smaller subset- we have chosen the 30th part of Qur'an only-"جزء عم".

2. DESIGN DECISIONS

The proposed application is designed to add to current programs in the Islamic world of applications and smart phones. As well as providing an application that uses the latest technologies available in order to attract the new generation of Muslims and users of new technologiesThe proposed application is not intended only

for speakers of Arabic, but it offers facets for dealing with other non-Arabic speaking users, one voice in Arabic and the other written in any language the user wants to use. The intention is to provide both easy communication and lots of redundancies in interaction with the application [1]. As dealing through touch screens is easy to understand application-specific modeling, the application is made easy and attractive. The modeling followed in design uses virtual reality to build the application so the user feels as if he is immersed inside the Holy Qur'an and it is animated in front of him with the versus [2], the Surahs, the interpretations and rulings are all accessible. This has taken care of by allowing the proposed model to be extended by adding sources and other books in addition to written interpretations, judgments and jurisprudence [3]. The use of interactive communication interface which is currently the most important success factors of the application seems perfectly valid to use in our current design.

Figure 1. Natural Segmentation of Surahs

In the design of the data handling part, as shown in figure 1, a Surah is divided into natural segments for ease of memorization [4]. This idea also expected to lead inside the immersion model of Qur'an and its Sciences to increase the capacity for collection and understanding of the meaning. Also, indexes and glossaries available in the application will lead to the ease of dealing with this vast amount of information [5]. Finally the Metro-Style interface of touch screens allows navigation through various Surahs and jumping from one place to another for both Qur'an text and audio (see figure 2).

Figure 2. Metro-Style Interface Touch Screen

3. SYSTEM ARCHITECTURE

Figure 3 shows the main interface of the application. This three-dimensional interface animation has a continuous movement during the recitation of verses and relevant display of Qur'an text at the bottom of the screen. This is the main interface of the application. The idea here is inspired by the interface of the GPS satellites, where a different hemisphere of the Earth corresponds to the Qur'an 114 versus. One finds a continent with every one of the Surahs of the Qur'an. The length of Surahs correlates with the areas of these continents. The locations of these continents are in harmony with the Surahs' places in Qur'an. Surrounding this Qur'an Earth 114 orbits; each is called with the name of each verse of the Qur'an (or continent), which mandates taking place in that orbit. Each orbit contains satellites equal to the number of versus of each Surah. For example, a continent of "Al-Fateha-الفاتحة", which mandates the orbit of "Al-Fateha" that holds rotating 7 satellites representing the versus of "Al-Fatihah". The representation of the verb "derived" in the last sentence in the preceding paragraph, is shown as the red/blue/yellow lines that extend from the continent (Surah) located on the Earth to its own Qur'anic (mandates) satellites located on the orbit named after Surah. This is meant to synchronize audio and reading biblical view of the Surahs with both spin the Earth on the

Qur'an itself and the satellite spin (verses) in the courses of the Earth. This synchronization is correlated with the verb "derived" so that red/blue/yellow lines disappear and new lines appear in a new orbit compatible with reading, voice continuation. The Ring Yellow Line in the middle of the Qur'an Earth represents the equator of the Earth Qur'an. It is used as a handle of the Earth to control the angle and direction of the Earth as well as the proximity and distance of the Earth form the viewer's eye. This animated interface is displayed on a smart phone screen or board of the PDA touch screen. When the user touches the circle of the equator and move at will, without lifting a finger from the screen he/she can control the angle and direction of the Earth and display as well as the proximity and distance during rotation. The vertical red line on the equator allows the user to lengthen or shorten the high orbit above the surface of the Earth Qur'an. As can the user through the touch screen chooses another control panel different readings, recitations, narrator, etc. to help end users hear the recitation of the Qur'an in seven ways.

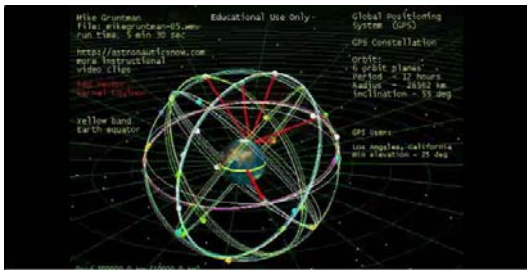

Figure 3. The Control Panel surrounding the Earth Qur'an

The Control Panel displays the well-known fourteen seven imams (Alkalon - Workshops - Albzi - Konbol province Doree - Company Soussi - Hisham - Iben Zkoan - Shoaba - Hafs - behind - Khallad - Abu alharth - Doree Al Kesaiee). Panel displays and controls are written in any language around the Earth Qur'an as shown in figure 4. The user can change places of the interface keys, forms and views. As well he/she can change at any time surah or verse, reader or narrator all this simply by touching the continent required or desired to touch the satellite in its path or open a drop-down list in the Control Panel to choose the desired action. We can do it all because of our rich modeling of the system to be a part of each object in itself such that it can be chosen and dealt with as programming objects (common methods currently in systems modeling and programming). For example, a verse is an object that can be selected at the touch of its own satellite, whether when its turn in reading or not. A verse can also be selected by entering the verse number and the name of Surah (or number). We made sure in this model is consistent with the graphical user interface so that multiple methods of choices and ways to accomplish a specific task are possible.

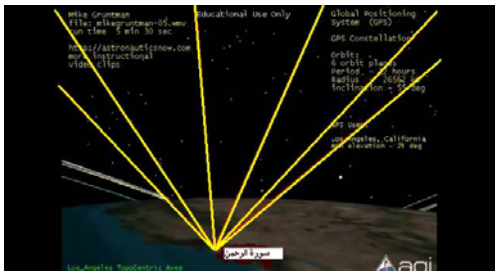

Figure 4. A Screenshot of Surah "الرحمن" showing Virtual Reality of Continent "الرحمن "with its Orbit and its Satellites

4. SMALL SCALE IMPLEMENTATION

We built a small scale of the application to work on smart phones, tablets and smart handheld devices such as iPhone, Android-Based Devices, BlackBerry, and Galaxy, to be available for free download from Windows Marketplace, Amazon, Store Apple Store, market, HP, and applications to store Mac. (see figures 5-13)

Figure 5. A Screenshot of the Surah "الفاتحة" showing Usage Statistics Capabilities

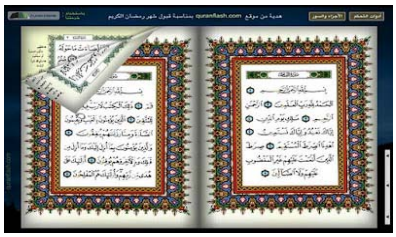

Figure 6. A Screenshot of Surah "الفاتحة-البقرة" showing Another Metro-Style navigation Capability

Figure 7. A Screenshot showing "تفسير المعانى بالانجليزية" for Surah "المؤمنون"

Figure 8. Touch Screen Selection opens a new menu- A Screenshot of Surah "جزء عم" showing the Selections Capabilities

Figure 9. A Screenshot of Surah " الفجر" showing Another text-Audio Display Capability

5. EXPERIMENTATIONS

We have chosen a number of end-users for testing the small scale implementation and to record their feedback. The intention is to be both easy to supply and communicate with and provide a lot of redundancy in interacting with the application. We asked the end-users to request any command and process it in more than one way. As well as dealing through touch screens that are easy to understand its application-specific.

Figure 10. Metro-Style Navigation in "جزء عم" showing Touch Screen Metro Navigation

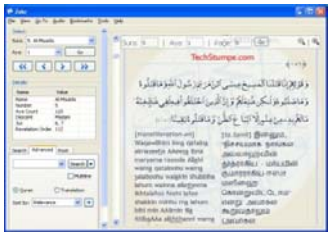

Figure 11. Testing the Indexing and bi-lingual Capabilities

The main technology used is virtual reality to build the application so that the user feels as if he/she is immersed inside the Holy Qur'an. Every object is materialized in 3D in front of him with signs, guidance, Surahs, interpretations and rulings. The application is open ended in the sense that we have started with part 30 and will add-on other parts incrementally. End users are asked to test the object-orientation of the interface and its usability. Then the use of animated interactive communicating interface which is currently

the most important success factor of the application of smart phones is assessed. End users are shown the animated interface and evaluated its effectiveness.

Figures show how the richness of indexes and glossaries available in the application has led to the ease of dealing with this vast amount of information. We have set up a testing strategy that involves a large number of target user groups that put the small scale implementation to use and provided us with their feedback. Figures show various End-users testing to the small scale implementation. Most of the feedback we have got from the End-Users were in the above average and good scales.

Figure 12. Testing the Arabic Tafseer Capabilities

Figure 13. Testing English Tafseer Capabilities

6. CONCLUSION

In this paper we have presented a small scale implementation of only Part 30 "جزء عم" of the Conversional, Animated Qur'an Memorizer application. The implementation is ported on major smart phones currently available and tested. We described the system model and design decisions. Major features of the application have been demonstrated and explained. The animated conversional interface is described with its options to change view and customize its drop down menus locations and contents. The flexible indexing of both Qur'an, its narrator, type of recitation, link to Tafseers and glossaries along with the metro-style touch screen navigation and bookmarking has been demonstrated. The search capability of both text and audio has been demonstrated. Tracking of what one has memorized from each Surah so far with ability to change text display through the Qur'an viewer (e.g. display movement characters (التشكيل)) are demonstrated. The bi-lingual display of Qur'an Tafseers and glossaries are also demonstrated. Changing setting and getting help are also demonstrated.

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LEARNING POTENTIALS OF THE UBIQUITOUS INTERNET: USING MOBILE DEVICES TO SUPPORT THE INDIVIDUAL, SOCIAL AND PHYSICAL CONTEXT OF THE LEARNER

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ABSTRACT

The aim of this paper is to identify the key learning potentials of the ubiquitous internet. Rather than focusing on mobile technology or the mobility of the learner, the paper emphasises the ubiquity of internet access as a paramount catalyst for new learning in the digital age. From a sociocultural perspective the paper discusses different ways in which the use of mobile devices can extend and augment the context of the learner. The learning potentials of the ubiquitous internet relate to the opportunities to extend the context of the learner on three levels: 1) personalisation of information and communication, 2) perpetual social contact and visibility, and 3) augmentation of the physical context with an additional layer of information.

KEYWORDS

Mobile learning, ubiquitous internet, sociocultural theory, learning potentials.

1. INTRODUCTION

The field of mobile learning has gone through a number of phases, which have shifted the focus of the field. Sharples (in Pachler, Bachmair & Cook, 2010) identifies three phases of mobile learning beginning with a focus in the mid 1990s on the devices (Quinn, 2000). Around the year 2000 focus began to shift towards research on mobile learning outside educational institutions, for instance in museums. Since around 2005, the focal point of attention within mobile learning has moved even more away from the technological devices and towards the mobility of the learner. Scanlon et al. (2005) state that: "Our approach to mobile learning [...] is not to focus on the technology but on the learner being mobile." (Scanlon et al., 2005: 2). Within this focus on the mobility of the learner, Sharples et al. (2007) and Pachler et al. (2010) emphasise the importance of context for learning.

Sharples et al. (2007) even define mobile learning in relation to changes of context. They define mobile learning as "the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies." (Sharples et al., 2007: 225). This paper will expand on this approach by developing an understanding of the concept of context and its relation to learning. The paper will put forward the argument that the learning potentials of mobile media relate to the opportunities of the technology to support and expand the context of the learner.

2. FROM MOBILE TECHNOLOGIES TO THE UBIQUITOUS INTERNET

The focus on context means that the term *mobile devices* is not adequate to describe the nature of the technology that holds the learning potentials. Mobile devices play a central role in widening the context of the learner, but more fundamentally, this is enabled by the individual's ubiquitous access to the internet (including the world wide web). This is, of course, to a great extent, made possible by mobile devices, but in an interplay with other devices such as computers and laptops. Access to the internet is key to understand the

learning potentials related to context. The learning potentials that we outline in this paper, are just as much enabled by the characteristics of the internet as they are by the mobility of devices. Thus, we wish to highlight the term *the ubiquitous internet*, and we will argue for a shift in focus within the field of mobile learning towards the concept of the ubiquitous internet. This also implies that the paper does not focus on the mobility of neither the devices nor the learner, which is central to the field of ubiquitous learning (Hwang et al, 2008; Yahya et al, 2010). From the point of view of this paper, the central point is *not* that the learner is mobile – in fact he/she has always been mobile (Jensen 2013) – but rather that the learner is able to extend his/her context and connect the given context to other contexts.

3. CONTEXT AS INDIVIDUAL, PHYSICAL AND SOCIAL

To develop a conception of context, the paper draws on sociocultural learning theory. The sociocultural framework is especially relevant, because it emphasises the role of context for learning (Vygotsky, 1978; Leontyev, 1981; Wertsch, 1998). Within a sociocultural framework, context is conceptualised by both physical surroundings, the social situation, and by the intentions and purposes of the individual.

According to sociocultural theory, the goal-directed actions of the individual are the basis for understanding learning. The concept of *goal-directed actions* is described by Dewey (1916), who argues that learning occurs through actions that have an aim or purpose. In other words, learning relates to the practice of the individual's actions. Lave & Wenger (1991) and Brown et al. (1998) take the approach a step further and argue that learning is situated in practice. According to Leontyev (1981) the actions of the individual and the situation of the individual's actions is placed within a sociocultural practice, which includes the actions of other people. In other words, actions are never strictly individual, because they always relate to actions of other individuals within an overall sociocultural practice. Consequently, different forms of social interaction become central to learning. According to the sociocultural approach of this article not only direct communication and collaboration is of importance to learning, but also the individual's insight into the activities of others who are related to the sociocultural practice.

From the sociocultural approach we conclude that the concept of context contains a physical, an individual and a social perspective. In that sense, both a physical, an individual and a social aspect of context becomes important to learning. Below we will elaborate on the potentials within each of the three aspects of context.

4. INDIVIDUAL CONTEXT

Within a sociocultural framework, an individual context of the learner is constituted by the aims, purposes, objectives and interests of the individual. The individual might be engaged in solving a specific problem, answering a question, or creating a product. The character of the directed nature of the individual will determine, how the individual reads a situation and will determine what is relevant for him/her in the given situation. In that sense, the individual's aims and purposes contribute to the individual nature of the context.

The concept of *personalisation* denotes that information and communication gets filtered and influenced by the individual context. Through personalisation, the context of the individual can be utilised in two different ways in relation to information and communication: 1) the user is active by providing and selecting information in a system (e.g. RSS feeds), and 2) the user's activities on websites are mined and analysed. This relates to the concept of *narrowcasting* (Lukács, 2007) which refers to an information strategy, where users are targeted with content through registration of their activity on the web, their preferences and their personal profile.

Personalisation plays a key role in the development of services for mobile devices; for instance, services that use push messages to provide information based on the profile of the individual. This can be accomplished by use of measurement points related to the individual's activity such as time, physical location, communication and previously accessed information. Also it is possible by registration of the user's continual use. Through a feedback loop constituted by continual and cumulative registration of the user, the user's selection of output information provides new input to the system, which - again - is used to generate an output of information targeted at the individual.

The learning potential of the ubiquitous internet in relation to the individual context of the learner is that information in different forms can be accessed in different correlations that the learner can piece together in order for them to suit his/her special purposes. Learning resources can provide personalised information based on the individual learner's objectives and purposes, and the students' previous use of information. In this way it is possible to target learners with relevant information such as new publications, new courses and relevant presentations based on their "personal profile".

5. SOCIAL CONTEXT

From a sociocultural approach, the social context of the learner consists of an overall sociocultural context surrounding the actions of the individual. The social context is constituted by other individuals, whose activities relate to the actions of the individual. For instance, the social context of a student writing an exam paper will, among other things, include other students, the teacher, the examiner, and administrative staff. An important aspect of the social context is that the individual might not be aware of the entire social context. For instance, a student might not be aware of formal demands set by the administration, or of the criteria that the teacher and examiner use in the evaluation of the assignment.

The technological developments over the last few centuries have taken place parallel to what Giddens (1990) refers to as the *disembedding* of human interaction, describing how social relations are lifted out of physical proximity and reconstructed across an indefinite range of time and space. This disembedding and recontextualisation of human relations has brought on an increased awareness of phenomena and events outside the immediate vicinity of the individual. Theorists like McLuhan (1964) and Castells (1996) have established a connection between the rise of media technologies like television and the internet and new shapes of human interaction, and claim respectively that the radical increase of the human radius of attention caused by media has given rise to the concept of the Global Village (McLuhan, 1964) and the Network Society (Castells, 1996).

The wide adoption of mobile devices with internet access and the subsequent ubiquity of the internet has led to a radicalisation of the disembedding of social relations described by Giddens (1990). Regardless of time and space the individual is now perpetually connected to the entirety of his/her social network. Even though not everybody is online all the time, central internet affordances like the network structure (Castells, 1996), the openness and visibility of communication and information (Hoem, 2006), and the combination of synchronous and asynchronous communication forms (Foulger, 2003) allow the individual to utilise a vast quantity of his/her social network in shaping the social context at a given time and place.

Web services like Facebook, Twitter and Google+ are constantly at hand due to the ubiquitous internet, and they allow us to establish, maintain and utilise personal connections anywhere and anytime. The easy access to social relations allows the individual to more extensively exploit what Granovetter (1973) has referred to as *the strength of weak ties*. Granovetter distinguishes between *strong ties* which consist mainly of family and close friends, and *weak ties* which denote more peripheral relations. Strong ties offer the individual security and confirmation, while the weak ties allow the individual to be presented with new information or unfamiliar standpoints, and allow the individual to seek out and join new communities, which transcend the closedness, that characterises the information and communication patterns of close relations (Granovetter, 1973; Baron, 2005). The perpetual contact (Katz & Aakhus, 2002) between weak ties created by the ubiquitous internet has led to an unprecedented openness in communication and has breached the closed perimeter of communication in physical contexts.

As already stated above, sociocultural theory emphasises that learning is always linked to a social context, and that social interaction, coordination and collaboration are important elements for learning. The individual's insight into other individuals' activities as well as an understanding of the general work he/she is involved in are factors that are central for learning. As a result of this there is a potential for learning in nourishing various forms of contact and visibility between individuals. The radicalised disembedding of social relations from physical settings manifested in the perpetual contact between individuals, means that the individual at any given time and space is able to expand his/her social context for learning.

The learning potential of the ubiquitous internet in relation to the social context of the learner is linked to the increased openness, contact and visibility between individuals otherwise separated by time or space. This

supports an expansion of the basis for reflection and strengthens the individual's opportunities to carry out his/her self-governed learning activities with the activities of others in mind.

6. PHYSICAL CONTEXT

The physical context of the learner consists of the conditions and opportunities of the given physical surroundings. Such conditions could be tools, books, paper, pencil, computers, etc. that the individual can employ to perform activities. Because conditions of the physical context according to the sociocultural approach are important to learning, context-sensitive information can potentially support and enhance learning.

In order to encompass the different dimensions of the impact of the physical context we have chosen to use the phrase *location specific communication and information which* can be defined as communication or information which is tagged with metadata such as latitude and longitude or which is induced by proximity of a specific location. This happens partly through the individuals reaction to the surroundings and partly through internet services using GPS technology to determine latitude and longitude of the user and by pulling data attached to a specific location.

As mentioned earlier it can be argued that the ubiquity of the internet has resulted in a radicalisation of the disembedding of social relations from physical proximity described by Giddens (1990). The increased location awareness (Gordon & e Silva 2011) seen among internet users today, can – however – be understood as a partly opposing tendency in that it induces a re-embedding of social relations and a focus on the near contexts of the individual. So while the individual now has a greater focus on things happening outside the immediate physical surroundings, the physical context at the same time holds a greater importance in communication and information.

From this perspective the development of location specific services has affected the way humans conceive the world and has created a greater emphasis on that which is physically near. The organising logic of the internet was earlier characterised by the parameters *what* (topics), *who* (relation) and *when* (points in time). However, the new development in internet technology and the actual use of these new technologies have added *where* (physical location) (Gordon & de Souza e Silva, 2011) to these parameters. When users of the internet navigate after this parameter it means that the internet manifests differently according to the location of the individual. The user will use different services and search for different topics according to the location he/she is in, and at the same time the location of the user also effects which content being presented to the users from the internet services. Moreover, the internet user can navigate through and filter the internet according to specific places he/she is interested in. The location specific navigation does not replace earlier organisation structures on the web, but gives the user the possibility to seamlessly navigate through that which is marked as physically near and that which is marked as conceptually near.

However, not only GPS-technology has affected the significance of the location in information and communication on the internet. The devices which we use to access the internet have become increasingly mobile, and they do not inhibit our agency in the world to the same extent as before. The actual or latent mobility makes it more interesting than earlier for our communication partners to know *where* we are when we communicate – a tendency already introduced as the first generations of cellular phones became popular towards the end of the last century (Laurier, 2001), and which has now become relevant anew.

When utilising technologies such as location based services, the physical context for learning is extended. The learning potential of the ubiquitous internet in relation to the physical context lies within its ability to augment the given context with an additional layer of information, which the individual can use to increase his/her opportunities for acting and learning.

7. CONCLUSION

In this paper we have proposed a shift in focus within the field of mobile learning towards the ubiquitous internet. We have argued for a shift in focus away from the mobile technologies and also away from a focus on the mobility of the learner. Instead, we have argued that the central learning potentials of mobile devices relate to the opportunities of the learner to utilise the ubiquitous internet to enhance his/her context.

From a sociocultural perspective, context can be viewed as an individual, a physical and social context. The ubiquitous internet can extend all three aspects of context. First of all, the ubiquitous internet can support the individual context of the learner by providing personalised information and in the form of personal tools that adapt to the aims and purposes of the individual. Secondly, the ubiquitous internet can support an enhancement of the social context through perpetual contact between individuals. Finally, the physical context of the learner can be supported by location specific information and communication, which can augment the context with an additional layer of information. Together, these three learning potentials of the ubiquitous internet can empower the individual learner to perform actions, answer questions, solve problems, etc. in new ways. The conclusions of the paper call for further research within the field of mobile learning with a focus on how individuals utilise the ubiquitous internet in different contexts and how they draw on mobile devices to enhance their context for learning.

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SMARTPHONES IN CLINICAL NURSING PRACTICE: A MULTIPHASED APPROACH TO IMPLEMENTATION AND DEPLOYMENT

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ABSTRACT

Students in the undergraduate nursing program at the University of Calgary - Qatar are required to work with patients in clinical settings under faculty supervision.. One of the main goals of clinical courses is to provide students with the opportunity to learn in context and 'just-in-time', a much more realistic and memorable learning experience. During clinical placements, students need to acquire additional information about illnesses, medication and patient care on site. The current research was conducted to determine if properly selected smartphone technology and accompanying software would help provide students with information they needed in a just-in-time fashion and if this would have a positive impact on their learning. A multi-phased study was developed to (1) determine the impact of smartphone and software deployment in clinical courses on student learning and to determine barriers and issues that may inhibit success [Phase 1] and (2) to use the knowledge gained in phase 1 to address these issues and barriers by optimizing e.g., deployment strategies [Phase 2]. Findings from phase 1 indicate success in terms of learning outcomes while also showing that students would prefer to use their own smartphones. Phase 2 is currently underway and will result in the development of implementation strategies based on evidence gained from phase 1 and mobile technology usage pattern survey (ECAR).

KEYWORDS

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

1. INTRODUCTION

There are many reasons for using smartphones in clinical healthcare settings. They provide just-in-time access to clinical reference tools as is evidenced by the widespread use by medical professionals (Wyatt et al., 2010; Farrell & Rose, 2008). They also have the potential to increase student interactions with instructors, peers and content (resources) and to provide the opportunity to engage in evidence-based-practice at point of care (Kenny, Van Neste, Park, Burton, and Meiers, 2009). Several models exist for deploying the smartphones and getting them to the students: (1) mobile technology may be provided by the educational institution either as part of the course materials (e.g., on a limited sign-out basis) or (2) permanently as part of their tuition costs (e.g., given a smartphone on entry into the program). In both cases the assumptions are that students do not already have similar technology and/or do not have the software required. These two may also inhibit a more ubiquitous adoption model (see e.g., Naismith, Lonsdale, Vavoula, & Sharples, 2004) resulting in students using the devices for very specific purposes and their own devices for everything else. Thus a third model may exist in cases where students can be expected to own mobile technology suitable for use in the learning environment facilitating opportunities for a more ubiquitous model of usage.

Mobile technology, specifically smartphones, is becoming omnipresent in many settings as costs of the technology and supporting infrastructure becomes more affordable and accessible. This presents opportunities for implementing and using mobile technology in a wider range of educational settings. However, the provision of mobile technology by educational institutions to their students becomes a major consideration as the numbers of e.g., smartphones deployed increases. It may also present opportunities to migrate the burden of managing mobile technology from educational institutions to the student. The following reports on a multi-phased study that begins with small targeted usage with the goal of piloting pedagogical strategies in nursing clinical settings and gaining an understanding of institution-led deployment

issues. The second phase explores the feasibility and rationale for migrating the supporting software to student-owned smartphones.

2. BACKGROUND

Currently, nursing students at University of Calgary - Qatar are limited in their ability to access relevant health care information in clinical placement settings. Few reference texts are available at clinical sites, and library electronic resources are generally not available or accessible in the clinical setting.

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

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

The ability to retrieve information while situated in the context of use presents the opportunity for a powerful learning experience during clinical placements. These opportunities to learn and to obtain just-in-time information should extend into practice after graduation. An implementation model that retains the technology in the hands of the educational institution may inhibit wider spread adoption.

3. METHODOLOGY

This study was conducted in two phases. The first phase was designed to pilot the use of smartphones in clinical settings in an undergraduate nursing program. Specific software was targeted for use and strategies developed for using the smartphones and software in clinical courses. This provided a standardization of hardware and software allowing for the control of mitigating variables such as differences in technology and/or software and installation and maintenance issues. The second phase was designed to migrate the software from the institutionally-owned smartphones to the students' smartphones.

3.1 Phase 1

Smartphone technology was selected based on its targeted use in clinical nursing courses in phase 1. Software was selected based on the goals of just-in-time use and evidence-based-practice and the context of use. A system of deployment and maintenance was established. Data was gathered through the use of focus groups conducted with faculty and students and through the use of software installed specifically to track program usage on the smartphones. Students were informed that their usage was being tracked but the actual tracking was invisible to them resulting in silent-tracking (Boticki & So, 2010)

3.1.1 Technology Selection

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

3.1.2 Software Selection

The target courses for deployment of the smartphones were clinical courses in the nursing curriculum. Pedagogical goals were to provide the students with relevant and useful just-in-time information which could then be used to help inform evidence-based practice. The most appropriate software for these purposes was found to be Skyscape (a modular program that includes drug guides, diagnosis and disease management tools, medical dictionary, etc.). Faculty members recommended the most appropriate software modules for the clinical courses that had been targeted for deployment. The software was installed on the smartphones prior to deployment.

3.1.3 Deployment

The strategy for deploying smartphones to students in clinical courses was developed over several semesters. Students enrolled in clinical courses were given permission to sign-out the smartphones for one semester. At the end of the semester the phones were returned and all student data and applications were cleared. Any necessary maintenance was performed and the phones were made ready for re-deployment in the upcoming semester.

3.2 Results: Phase 1

3.2.1 Student Usage Characteristics

It was originally planned to gather usage data when the smartphones were returned at the end of eachsemester. However, due to scheduling issues at the end of the first semester the data was not gathered and only the data from semester two was obtained.This resulted in data being gathered from 14 students. The database on the smartphone was then cleared in preparation for the next clinical course deployment. The software, 'AppUsage', collected data by counting the number of times an application was opened. It did not capture the length of time the application was open. Figure 1 shows the number of times applications were used (opened).

As figure 1 suggests the two applications that were used most often was the internet browser and the Skyscape software. The average use was 126 for internet use and 110 for Skyscape. The internet usage showed that 10 of the 14 users opened the internet application 24 times or more with four students using the internet regularly (275 to 415 times). The Skyscape usage showed higher usage patterns for all students with a range of 7 to 440 with 10 of the 14 students opening the application 50 or more times. Students also used the Settings applications an average of 37 times. They would have had to enter the application a number of times to setup and maintain wireless internet access settings. Only 5 students used messaging more than once or twice, these 5 used it more than 30 times suggesting these users may have installed a SIM card (required for phone and messaging service). Of particular interest is the very small number who used the email application particularly as this would have provided access to their email at all times. Only 1 student used the application regularly. However, it should also be noted that web-based email is the preferred way to access email by most students perhaps explaining the high number of internet accesses. Unfortunately this was not followed up in the focus groups.

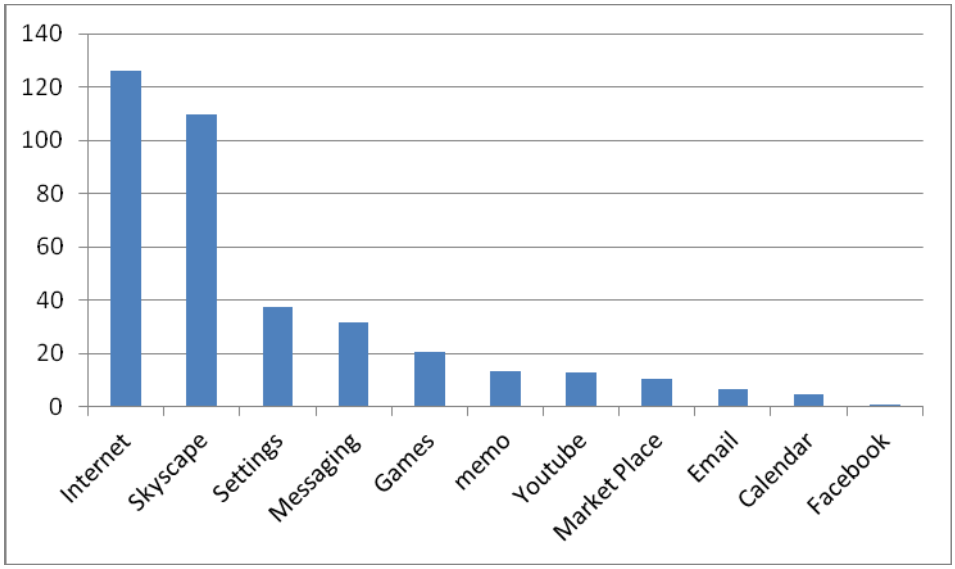

Figure 1. Average student usage data by number of uses.

3.2.2 Pedagogical Evaluation

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

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

Both groups felt that a small amount of training would have been beneficial in terms of using the smartphones and software. A significant number of students indicated that the smartphones provided were not the same as their personal smartphones. This meant that they needed to learn their way around a new software interface. One student captured the sentiment, “on my own phone I could close my eyes and get to what I want.” Virtually all felt that having them available in clinical was clearly an appropriate use.

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

3.2.3 Deployment Evaluation

After several semesters of use, the research team also conducted a review of the deployment practices. This review highlighted a number of issues that were becoming more evident as the number of smartphones deployed grew. The issues included the increasing amount of time required to clean and prepare the phones at the end of each semester as well as issues around areas of responsibility. This was exacerbated as we acquired additional smartphones. It was not possible to acquire the same version of the phone resulting in two slightly different sets of processes for cleaning and preparing the smartphones for (re-) deployment.

In our setting the Learning Commons (our local library) had agreed to distribute and maintain the smartphones as they already managed a daily laptop sign-out service. The Learning Commons staff became the point of first contact for students. Students obtained their phones from staff and returned them to the same location. When phones failed to work properly they were taken to the same staff. A system of triage was conducted to determine if the phones needed to be returned to IT for repair or if the problem could be resolved by the staff member.

There was considerable discussion around who was responsible for various elements of the smartphone maintenance, including initial setup and ongoing service, semester-end cleanup, installation of software, and

deployment management. Organizational and flowcharts were developed to help understand the process. Detailed maintenance schedules and checklists were also developed to help standardize and systematize the workload. However, all involved felt these were not scalable solutions. At this point there were roughly 75 smartphones in service and it was anticipated that the annual growth rate of the nursing program would result in the need for double or triple the number of smartphones necessary to meet the demand.

3.3 Phase 2

Phase 2 is currently in the development stage. The aim of this phase is to provide mechanisms to migrate the software (e.g., Skyscape in our case) to student-owned smartphones. This involves investigations designed to confirm the prevalence of personal (student- owned) smartphones suitable for the software and the usage intended. Investigations are also being conducted into the best way to deploy the software onto student phones (e.g., pricing, installation, maintenance, etc.).

3.3.1 Usage Survey

Although anecdotal evidence from students throughout the study suggested that a large percentage of students could be expected to own their own smartphones there was a need to quantify this before going forward. Earlier feedback through focus groups had suggested that there were a number of different types of phones in common usage with common software usage patterns (e.g., use of Blackberry Messenger on Blackberry phones, Whatsup on Android phones, etc.). Permission to use the ECAR Mobile Technology Survey (Educause, 2012), developed by the Educause group, was obtained to ensure that a sufficiently broad range of relevant data was captured. Information from this survey includes types of mobile technology owned and used, type and frequency of software use, and perceptions of the importance of this software to the participants academic success. The survey is currently deployed to the nursing student body at the University of Calgary - Qatar.

3.3.2 Deployment Strategy Options

There are currently several deployment options being considered. These include (1) continuing to provide smartphones to students as is currently the practice, (2) students independently purchase and install the Skyscape software on their own phones prior to beginning a clinical course, or (3) a hybrid model where students will pay for the software but UCQ will assist in the purchasing and installation similar to the purchase of course textbooks.

As has been discussed above, the first option does not scale well and has become onerous to manage. It also does not leverage student phone ownership and usage patterns. The second option provides the students with the most independence but may not provide the best pricing or installation support desired. At present, the third option seems optimal.

The issue of equity must also be considered. Students who are not financially able to purchase their own software or do not own smartphones can make application to the study team to sign-out phones from the existing pool of smartphones.

Finally, training will be provided based on the feedback obtained thus far and based on the results of the ECAR survey.

4. CONCLUSION

Smartphone usage in clinical nursing courses has shown to be beneficial and was confirmed in this study. Every attempt was made to select appropriate technology for a clearly defined need and yet ensure the technology would have wider application within and throughout the nursing program. Feedback from students suggested that the just-in-time availability of concise and easy to understand information helped them explore their patients' cases more fully and in so doing, improved their learning. However, feedback also suggested that students would prefer to have the software on their own smartphones. Reasons included personalization, familiarity with their own phones, and the ability to keep the software throughout their program and post graduation.

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TRANSMEDIA STORYBUILDING IN SLOYD

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ABSTRACT

This paper describes the theoretical foundation for a work in progress project of developing a mobile learning solution for sloyd education named Talking Tools (TT). Being a learner in a multimodal, blended learning environment entails both consuming and creating own content using a number of media sources and tools. For sloyd education, this multimodal learning experience can be seen as transmedia storybuilding, in which dynamic content facilitates learning by multiple and flexible stimulations. The learning process is the learners' own stories created through their transmedia learning experiences. We will look at the learning process of learners using the mobile learning solution from of a socio-cultural perspective of appropriating tools for learning. Phases of development are outlined in the paper.

KEYWORDS

Learning Process, Transmedia Storybuilding, Mobile Learning, Sloyd

1. INTRODUCTION

The fact that smart phones are found in the pocket of nearly every student in Finland opens up for endless opportunities of educational software development. This is a tremendous educational resource to exploit (Ilomäki, 2012). The purpose of this paper is to describe the theoretical foundation for the development of Talking Tools (TT), a mobile learning management system for smart phones, which supports both independent and collaborative learning and allows for flexible information access, communication, and documentation (c.f. Naidu, 2008). We will present how this mobile learning solution aims to enhance the learning experience in sloyd (slöjd) education. Research aims and questions are discussed within a socio-cultural framework while using terminology of transmedia learning.

Sloyd is a compulsory subject taught in primary schools in Finland. In the sloyd class, learners design and manufacture unique artifacts in a multifaceted process involving several steps and decision making. In this process various materials are being intentionally processed by hand into tangible artifacts (Kojonkoski-Rännäli, 1995). The sloyd class is student centered and allows every student to work from their own ability and motivation in creating artifacts. This includes both intellectual and manual work. The problem is that these individual processes often demand hands-on instruction and guidance on an individual level. Traditionally, the teacher guides and demonstrates sloyd techniques on demand, as there is a lack of ready made instructional material, which would be flexible enough to support the individual learning process. One purpose of TT is to provide easily accessible digital material and demonstrations of sloyd processes, which would free up the teacher's time for individual guidance instead of having a strong emphasis on lecturing. Another purpose is to allow the students to document and discuss their own creative process (Johansson & Porko-Hudd, 2012).

The TT development is a collaborative project between sloyd education researchers, transmedia developers, user experience experts, and educational technology researchers at XX, as well as software developers and coding experts at UpCode Ltd., a software company specialized in developing reading and scanning solutions for smartphones.

2. TRANSMEDIA STORYBUILDING

In sloyd education there is a pedagogical value in the story surrounding the creative process. The artifacts made in sloyd class can be seen as a type of communication and storytelling in itself (Mäkelä, 2011). We want to encourage learners to build their own story in order to capture the essence of the why, how and what within the creative sloyd process. Students can with the help of TT visualize their story of the product they are making as well as their learning related to this process. The learning resources or in other words the transmedia affordances provided by TT, involves utilizing a variety of media tools that complement each other. When the learning process flows between the design and manufacturing of tangible artifacts and a number of media tools and learning objects it becomes transmedia learning; a blended and dynamic content method to facilitate learning (Teske & Horstman, 2012). The objective is to stimulate learners in multiple ways and allow them to get different perspectives: learning by watching/listening, learning by doing, learning by sharing, learning by collaborating, learning by reflecting on one's process as a whole, as well as learning by being exposed to variations of processes through other learners' stories. We refer to the flow of the story utilizing a variety of media tools for the purpose of learning, as a "learning process of transmedia storybuilding" (see Figure 1).

We argue that humans are by default transmedia storybuilders based on our multichannel sensory system and multimodal brain. Our perceptual and sensory systems are the source of our conscious experience (Faucoinner & Turner, 2002). Sight, hearing, touch, smell, and taste are our bodies "tools" to experience various perceptions from a variety of perspectives. Our cognitive and emotional brain interprets these perceptions into experiences. Learning is the process whereby knowledge is created through the transformation of experience (Kolb, 1984). Media tools function as extensions of our bodies (McLuhan, 1964) and, hence, educational media tools can be described as extensions of our bodies and senses to assist transformation of experiences into knowledge.

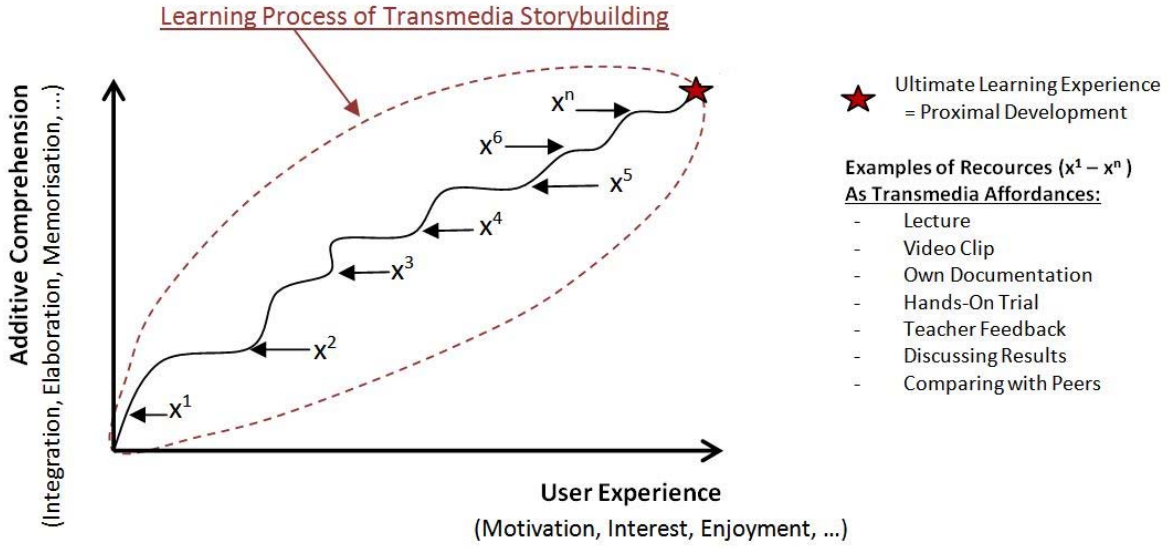

Figure 1. Illustrating potential learner choices resulting in an individual learning process of transmedia storybuilding, eventually reaching an ultimate learning experience and proximal development.

Multimodal affordances in the learning environment allows for transmedia storybuilding as illustrated in Figure 1. This provides variations of perspectives on content, and consequently optimizes opportunities for learning (Sankey, Birch & Gardiner, 2010). Every step in the transmedia flow allows for additive comprehension and adds to our understanding (Jenkins, 2006). This equals the hypothesis that we learn better the more different ways we learn something. Figure 1 shows how examples of learning resources ($x^1 – x^n$), or in other words transmedia affordances of the multimodal learning environment, are assisting the learning process both in reaching a better understanding of the subject, and in gaining a more positive learning experience. The aim of the variety of transmedia affordances is to allow students to learn more (additive comprehension) and increase positive emotions (user experience). The assumption is that the ultimate

learning experience, and hence proximal development, is the result of deep learning and high motivation. Note that the examples $x^1 – x^n$ in the figure could be any learning resource in any variety of order chosen by each learner individually. This results in unique learning processes of transmedia storybuilding depending on the choice of resources and the learner's own voice in the conversation.

3. A SOCIO-CULTURAL PERSPECTIVE

ICT has changed the way we communicate, behave, socialize, and provides a powerful tool for learning. Today, socio-cultural theory, in which learning is based on the relation between the collective and the individual, is relevant in the design of educational technology where social media often is an important ingredient. This theoretical approach sees our learning in relation to the context we live in, the tools we work with, and the social context we are a part of (Säljö & Linderot, 2002). Social learning theorists would argue that learning could even be constrained by the lack of social presence as development of knowledge is a social process (Naidu, 2008). The use of social media ingredients in TT supports self-studies, but it supports peer learning in particular, where all learners learn from each other, teach each other and advise each other.

When technological tools change, it also changes how we interact with the world around us, but also the way we learn and acquire knowledge (Säljö & Linderot, 2002). The characteristics of the medium itself will affect society (McLuhan, 1964). ICT allows for new strategies of solving problems and provides an atmosphere of trial-and-error-testing for learning. This gives permission for error-making, which then is seen as a step in the process of learning instead of being judged as being right or wrong as an end-result (Säljö & Linderot, 2002). Mistakes made during a creative process are often crucial steps in order to reach an optimal solution (Beard & Wilson, 2002). This new approach towards error-making is of significance for how we learn, and learn to learn in new ways with the help of ICT. It is a socio-cultural perspective for understanding how human learning functions in terms of appropriating new tools in our environment (Säljö & Linderot, 2002). We want to emphasize on this, since it is part of what this research is aiming for; investigating the learning process while using new technological tools and learning objects as a means for learning – both from a learner as well as a teacher perspective.

One important function of TT is to visualize the learning process and make it a transparent entity for the learners to reflect on. The learning objects created for TT holds content about techniques, materials and tools used in sloyd. These learning objects are small chunks of content which, being a variety of shapes and sizes, are difficult to assemble in a meaningful way without some kind of contextual glue to hold them together and give the combination a meaning, "bricks held together and made meaningful by a contextual mortar" (Wiley, 2008, p. 348). Transmedia seams are the choices of actions you make for learning in a transmedia learning process. These choices determine which path you take and which "bricks of content" to build your story with. Learner choices function as bricks and the learner's work process is the contextual mortar or glue that gives the individual learning objects a greater meaning.

The multimodal affordances provided by a blended learning environment assist a transmedia storybuilding process, which allows for additive comprehension of the learning content. The idea behind using transmedia content is to make the learning situation flexible and make use of tools that can enhance and visualize materials in multiple ways. In this transmedia flow the learners add their own "voices" through their active participation. It is the voices of co-creation in the sloyd conversation. The intention is to put the learner through a constructive act, not merely transmit content. The story created in this transmedia content flow is ultimately the learner's, although, to some extent structured according to a specific instructional design by the teacher. The learners are producers/designers/directors of their learning experiences.

The two significant factors for understanding mobile learning and its implication for education are conversation and context. Sharples, Taylor and Vavoula (2007) propose a tentative definition of mobile learning as "the processes of coming to know through conversations across multiple contexts among people and personal interactive technologies". They "claim that conversation is the driving process of learning" (ibid, p. 225), and that "all activity is performed in context /../ learning not only occurs in a context, it also creates context through continual interaction" (ibid, p. 230). They use Gordon Pask's conversation theory and Engeström's activity theory as stepping stones in their attempt to create a theory of mobile learning. One transmedia affordance of TT is, for instance, microblogging. This provides students with opportunities for creating a conversation around their sloyd projects.

4. CURRENT PHASE OF ITERATIVE DEVELOPMENT AND TESTING

Table 1 illustrates the phases of development of the mobile learning application Talking Tools, as well as the collaboration between Sloyd Teacher Education (SE), MediaCity (MC), and UpCode Ltd. (UC). Part of this involves continuous testing of iterations of both content and the user interface of the mobile application during development. At the time of writing educational video material to be used in the mobile application has been filmed, edited, and tested on the target audience. The next phase is to test a mock-up of the user interface in order to check understandability and usability of the interface design, as well as users' expectations of the product, and experiences of the brand Talking Tools.

Table 1. Phases of interface design and iterative development of the Talking Tools mobile learning application.

Phases	Interface Design and Iterative Development	Collaboration
Concept	Idea based on educational need	SE
	Planning concept	SE, MC, UC
Video Content	Scripting videos	SE
	Filming first videos	SE, MC
	Editing first videos	MC
	UX-Testing videos	MC
App	Planning mobile app	SE, MC
Iteration 1	Concept & interface mock-up	SE, MC, UC
	Coding interface	UC
	Feedback discussion	SE, MC, UC
App Mock-up	Mock-up of interface	SE, MC
Iteration 2	Testing mock-up	MC
	Feedback discussion	SE, MC, UC
App	Coding interface	UC
Iteration 2	Testing	MC
	Feedback discussion	SE, MC, UC
Final app	Testing in real life learning situations	SE, MC
	Researching the added value for learning	SE, MC
Guidelines	Writing guidelines based on research and best practices	SE
New subjects	Developing the app for other subjects	SE, MC, UC
Goals	Dissemination of research results	SE, MC, UC
	World wide marketing	SE, MC, UC

SE = Sloyed Teacher Ed, Åbo Akademi University; **MC** = MediaCity, Åbo Akademi University; **UC** = UpCode Ltd

On the finished mobile application, we will be testing usability and user experience in relation to both self-regulated learning and co-regulation in classroom situations using both laboratory methods and etnographic research methods. Research will be conducted on how the application assists the learning process, in order to be able to develop guidelines for teachers on how to apply it in educational situations. We simply want to find out what the added value of Talking Tools is for learning in various contexts.

5. CONCLUDING ASSUMPTIONS AND QUESTIONS

One of our assumptions is that learning resources allowing for transmedia storybuilding in learning broadens the horizon of proximal development. We want to know if this is true, and how this is true, in the case of TT. Our research questions include an appropriating perspective: How does this new tool for mobile and multimodal transmedia learning change how we act, interact, teach and learn in sloyd education? How are sloyd learning activities enhanced, facilitated, and supported by the use of TT? How do learners create their own transmedia story within the sloyd learning process assisted by TT?

Another assumption is that learning, as in integrating, elaborating, memorization, etc., increases with positive emotions. In other words, the assumption is that comprehension and user experience are interrelated in the learning process of transmedia storybuilding. Therefore, we assume that tools for additive comprehension enable increased motivation, interest and enjoyment, and vice versa.

Our research questions further include a designer perspective: What can we learn from a learning design perspective about the TT-based transmedia learning experience, in which the story is created across a number

of media tools and fragmented learning objects? How is learning related to user experience in the transmedia storybuilding process? How are the voices of co-creation influencing the conversation in the sloyd class and outside?

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MOBILE LEARNING IN SECONDARY EDUCATION: PERCEPTIONS AND ACCEPTANCE OF TABLETS OF TEACHERS AND PUPILS

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ABSTRACT

This paper reports on the introduction of the tablet computer as a personal, mobile learning tool in a secondary school in Flanders, Belgium. In this longitudinal research project, drawing upon the Theory of Planned Behavior, we question the relative extent to which attitude, subjective norm, and self-efficacy explain the prospective uptake of the device for educational purposes. The results indicate that attitudes towards the rollout are generally positive. Teachers are dominantly intrinsically motivated, welcoming it as a useful and easy to use aid. The role of attitude among pupils is strong, however they do report feelings of social influence, albeit mostly by parents and peers. The pupils also consider the tablet as instrumental, although their positive attitude is strongly linked to the expectation of having a more enjoyable learning experience.

KEYWORDS

Mobile learning, tablet computer, secondary education, Theory of Planned Behavior.

1. INTRODUCTION

In the digital age, technology cannot be ignored, especially in education. Continuous efforts are made to improve and support computer-assisted learning, integrating mobile technologies such as tablets and smartphones in education settings (Alvarez, Brown, & Nussbaum, 2011). The growing interest is understandable. Mobile technologies are flexible, students own the device and have control of the learning process. As such, mobiles technologies offer novel possibilities to enhance the learning environment (Melhuish & Falloon, 2010).

In this paper, we report the results of a study into the expectations towards the introduction of personal tablet computers (i.e. the Apple iPad) in a secondary school in Flanders, Belgium. At the beginning of the school year, all students and teachers owned a personal tablet to be used in both class and home environments. Although preliminary research corroborates the potential of tablets in education, supporting motivation and collaboration (Alvarez et al., 2011; Kinash, Brand, & Mathew, 2012, Zhang & Betts, 2012), such a disruptive implementation or an innovation also might bring about skepticism, or even resistance. For example, opponents in the public debate can point to the alleged hype-factor, financial burden, and question the actual motivational and supportive ability of tablets in education. As such, it is imperative to be able to rely on a solid support for such an introduction, to know what the reasons for this support are, and to be able to meet up with the expectations they bring along. Mobile devices such as tablet PC's could students help to learn independently from time and space and can foster learning. Students have always their library nearby where they have access with the whole world wide web. However, to realize the benefits of mobile learning, first students and teachers have to accept and adopt mobile learning (Cheon, Lee, Crooks, & Song, 2012). Because the availability of tablet PC's does not imply learning will happen, we must explore the acceptance

and perception of such devices in education (Corbeil & Valdes-Corbeil, 2007; Keller, 2011; Cheon et al., 2012).

Hence, in this research, we question the extent to which primary stakeholders, i.e. teachers and pupils, in this particular case are in favor of embracing the tablet as a mobile, educational tool, and why that is so. Is it because of intrinsic values, or because the innovation is pushed through by the school's principal decision makers?

2. THEORETICAL FRAMEWORK

To research this matter, we rely on the Theory of Planned Behavior (TPB) as a guiding framework (Ajzen, 1991), moreover the Decomposed Theory of Planned Behavior (Taylor & Todd, 1995). This model with the core concepts of TPB comprises an elaboration of the Technology Acceptance Model (TAM) (Davis, 1989), which is in turn based on the Theory of Reasoned Action. The Technology Acceptance Model (TAM) (Davis, 1989) is a model, which explains how users accept and use a technology and has the purpose to predict the acceptability of a tool. TAM's conceptual underpinning is that the attitude towards a technology originates in the recognition of the technology as useful and easy to use. The TPB extends this notion in multiple ways. First of all, it also includes subjective norm, reflecting social influence to accept a technology, as well as perceived behavioral control, i.e. the sense to master the new technology. Hence, the TPB is highly suitable for situations in which users do not have complete control over what they are supposed to do. Secondly, TPB does not solely rely on the beliefs users have about the attributes of an innovation, but instead weighs them with the evaluations of these very same attributes (Taylor & Todd, 1995). The TPB has been applied in various contexts such as technology and health care (Cheon et al., 2011). Yet, Taylor and Todd (1995) stated that those who are looking for a more comprehensive perception of intentions should use the decomposed theory of planned behavior model. This extended model of the TPB gives a deeper insight into beliefs systems that contribute to classroom computer usage issues (Smarkola, 2008).

In the present study, we first question to what extent the core concepts of the TPB explain the intention of both teachers and pupils to use the tablet for school. That is, (RQ1) what is the relative extent to which attitude, subjective norm and self-efficacy explain variance in the behavioral intention of both stakeholders? Next, the substrate of the attitude and subjective norm are examined. We explore (RQ 2) the extent to which both instrumental (i.e. perceived usefulness and perceived ease of use) as well as more affective factors (i.e. status and perceived enjoyment) explain attitude. Finally, we look into the origins of subjective norm, (RQ 3) inquiring the extent to which other stakeholders exercise influence.

3. METHODOLOGY

The present study took place in a secondary school in Flanders, including 83 teachers and 694 pupils. At the beginning of the school year, each respondent purchased a personal tablet to be used at school as well as at home. The present survey, which is part of an ongoing longitudinal research project, was administered at the first day of school and hence concerns teachers' and pupil's expectations towards using the tablet. The data were collected through an online questionnaire on the respondents' personal tablet device. The survey draws upon prior applications of the decomposed theory of planned behavior. Besides socio-demographic details, it contains measures of attitude (M_t = 3.84, SD_t = .83, α_t =.95; M_p = 3.46, SD_p = 1.01, α_p =.91), subjective norm (M_t = 3.18, SD_t = .90, α_t = .95; M_p = 3.15, SD_p = .84, α_p =.83), controllability (i.e. self-efficacy), and behavioral intention (M_t = 3.80, SD_t = .77, α_t = .87; M_p = 5.80, SD_p = .99, α_p =.83). Moreover, these measures were supplemented with lower-level measures of perceived usefulness, perceived ease of use, perceived enjoyment and status for attitude, and influence by the school board, parents, pupils/peers, and colleagues/teachers for subjective norm (See Table 1). The lower-level measures were composed by multiplying beliefs (b) and outcome evaluations items (e). Both beliefs (i.e. the extent one agrees with an attribute) and outcome evaluations (i.e. the extent one considers an attribute important) were measured on a five-point Likert scale. The behavioral intention construct comprised six items, covering studying and tasks in school as well as for homework. Items were measured on five-point Likert scales ranging from 'never' to 'very often'. All measurement items were inspired by previous TPB applications.

Table 1. Descriptive statistics for the lower-level decomposed TPB measures, composed by summing item-wise multiplications of belief and outcome evaluation. These sums were later divided by the number of constituent items. As such, the variables range from 1-25, i.e. 5*5. [+] refers to single-item measures, not requiring a test of internal consistency.

	Teachers' Σb*e			Pupils' Σb*e		
	M	*SD*	α	*M*	*SD*	α
Perceived Usefulness	14.04	4.05	.88	14.13	4.09	.83
Perceived Ease of Use	13.67	4.22	.92	13.64	4.31	.86
Perceived Enjoyment	14.04	5.02	.95	13.49	5.35	.93
Status	6.54	3.59	.88	6.78	3.66	.82
Parents[+]	11.68	3.30	-	12.13	5.31	-
School board[+]	16.96	4.16	-	14.84	5.25	-
Peers[+]	-	-	-	9.16	4.32	-
Pupils[+]	11.87	3.90	-	-	-	-
Colleagues[+]	11.42	3.67	-	-	-	-
Teachers[+]	-	-	-	13.64	4.76	-
Self-efficacy	13.14	4.25	.87	14.94	4.56	.86

4. RESULTS

Before addressing the proposed research questions, we looked into the mean levels of the magnitude of attitudes and subjective norm of both teachers and students. One-sample t-tests, using the scales midpoint as a point of reference indicate that attitude's mean level is significantly higher for both teachers [$t(75) = 8.80$, $p < .001$] and students [$t(681) = 11.78$, $p < .001$]. Feelings of subjective norm are higher for students [$t(681) = 4.65$, $p < .001$], but not for teachers [$t(75) = 1.73$, $p > .05$].

To answer the first research question, considering the extent to which basic TBP blocks explain variance in behavioral intention (Ajzen, 1991), two regression models were computed (Table 2). Attitude, subjective norm and self-efficacy were simultaneously employed as independent variables. The teacher model accounts for a substantial amount of variance (43%) in behavioral intention. Yet, there is only a significant effect of attitude, indicating that teachers' prospective use is solely determined by their attitudes. As such, teachers' acceptance of the tablet appears intrinsically motivated. Social influence appears not to matter, as well as the sense of self-efficacy. The pupil regression model accounts for a substantially lower amount of variance in intention (25%). Nevertheless, all three independent variables contribute to the model. Similar to teachers, attitude is a relatively strong explanatory variable hence indicating intrinsic motivation to embrace the tablet in future educational contexts. However, there are also significant effects of self-efficacy and subjective norm. The former reveals that issues concerning the aptitude of using the technology influence the prospective uptake, an important issue that needs to be taken into account. The latter indicates that regarding pupils, social influence has a minor, yet significant role, albeit to a much lesser extent than the other two tested variables.

Table 2. Multiple regression models with Behavioral Intention as dependent variable.

	Teachers (R^2 = .43)			Pupils (R^2 = .25)		
	β	*t*	*p*	β	*t*	*p*
Attitude	.54	3.94	.000	.34	7.55	.000
Subjective Norm	.09	.80	.424	.08	1.88	.061
Self-Efficacy	.10	.87	.385	.17	4.30	.000
F(df)	18.45 (3, 72), $p < .001$			76.35 (3, 678), $p < .001$		

Next, a second set of regression models were computed to test the explanatory performance of classic TPB measures of perceived usefulness and perceived ease of use in explaining attitude (See Table 3). As previously mentioned, this is the most important factor in explaining behavioral intention. As argued in the introduction, perceived enjoyment and status were added to the equation. For teachers, this results in a highly satisfactory amount of variance accounted for (59%) in the attitude measure. Nevertheless, only independent variables with a direct instrumental nature proved as significant indicators, i.e. perceived usefulness and perceived ease of use. The pupil model renders a similar variance-accounted-for (60%). However, it is the perceived enjoyment measure that yields the strongest effect, followed by perceived usefulness, status and

perceived ease of use. This suggests a mixture of both prospective pleasure and utility. As such, the teacher and pupil model relatively mirror each other.

Table 3. Multiple regression models with Attitude as dependent variable.

	Teachers (R^2 = .59)			Pupils (R^2 = .60)		
	β	*t*	*p*	β	*t*	*p*
Perceived Usefulness	.33	2.12	.037	.31	8.46	.000
Perceived Ease of Use	.32	2.76	.007	.12	3.48	.001
Perceived Enjoyment	.12	.89	.379	.41	11.53	.000
Status	.15	1.71	.092	.06	2.23	.026
F(df)	.59 (4, 71), $p < .001$			249.82 (4, 677), $p < .001$		

Finally, the third research question is addressed by computing two additional multiple regression models (See Table 4). As previously found, subjective norm has no effect on the behavioral intention of teachers. Hence, it does not play a role in the decision to accept the tablet in their work practice. Moreover, it shows that their conception of subjective norm does not originate in any of the supposed relevant stakeholders in the school's ecosystem, i.e. pupils and their parents, the school's board and teachers' colleagues. In fact, the closest candidate is the influence of colleagues, which is marginally significant. More interesting is the pupil model, accounting for one-third of the variance in subjective norm. As noticed in the previous analysis, social influence exercises a minor, yet substantial role. A correlational analysis reveals that all four tested factors are significantly related to pupils' subjective norm (r = .33-.55, $p < .001$). Still, when simultaneously implemented in a single regression model, the peer and parental influences prevail. This indicates that despite the institutional push by the board of directors and teachers, what really matters in supporting the uptake of the device for school, are the social actors closest to the pupils.

Table 4. Multiple regression models with Subjective Norm as dependent variable.

	Teachers (R^2 = .13)				Pupils (R^2 = .33)		
	β	*t*	*p*		β	*t*	*P*
Pupils	.09	.56	.577	Peers	.17	4.62	.000
Parents	-.04	-.25	.807	Parents	.47	11.41	.000
Directors	-.03	-.26	.796	Directors	-.02	-.47	.637
Colleagues	.34	1.83	.071	Teachers	.04	.80	.424
F(df)	2.54 (4, 71), $p < .05$			*F*(df)	83.48 (4, 677), $p < .001$		

5. DISCUSSION AND CONCLUSION

This study shows that, as for this specific case, both teachers and pupils generally have positive attitudes towards tablets. As such, both express great expectations for using them in class and beyond. Those findings are in line with previous research discussed in the introduction. Still, there are apparent differences concerning the substrate for behavioral intention. Subjective norm does not play a role in teachers' acceptance, as they are uniquely intrinsically motivated, through their attitude. This attitude is especially made up by instrumental considerations on the usefulness and ease of use of the tool. Students on the other hand do report a minor influence of subjective norm, indicating that they feel somewhat pushed to embrace the technology. Surprisingly, it is not so much the school that accounts for this, as much as peers and parents do. Nevertheless, the pupils' positive attitude is a stronger factor. Unlike their teachers, pupils mix instrumental considerations with more affective ones, especially the prospect of enjoying working with the tablet. However, this high expectation introduces a major challenge for the success of using the tablet. There is a vast opportunity of motivating pupils, introducing more joy into the learning experience, albeit on the conditions that the actual appropriation will have to live up to the beliefs of having a nicer learning experience.

This challenges teaching practices and the (further) development of learning materials. Venues for further research are manifold. First of all, we plan to complement this study with supplementary waves of data collection, probing actual experiences during the school year, thus adding a longitudinal component. Second, we plan to engage in ethnographic research, examining hands-on experiences from both pupils and teachers and to explore new possibilities of using mobile devices like tablets in secondary education.

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ONDIGITA: A PLATFORM FOR THE MANAGEMENT AND DELIVERY OF DIGITAL DOCUMENTS

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ABSTRACT

This paper presents Ondigita, a platform developed at the University of Applied Sciences of Southern Switzerland for the management and delivery of digital documents to students enrolled in bachelor's courses in various curricula within the field of engineering. Ondigita allows our organization to have a cloud-based repository of educational materials (documents, books, audio and video) and allows our students to store and access these resources from their computers, tablets, or mobile phones. A specific Android mobile app automatically synchronizes the student's device with the learning resources provided by the teacher and stored in Ondigita, and automatically fetches all documents for the courses the student is enrolled in. Ondigita is built with the purpose of creating an infrastructure that will allow students to annotate their PDF educational materials, to take notes in a personal notepad, and to share annotations with teachers and peers.

KEYWORDS

Digital materials, document management system, document annotations, learning management systems

1. INTRODUCTION

In recent years we have witnessed a revolution in the production and delivery of instructional materials in schools, universities and educational organizations in general. The internet phenomena has revolutionized the approach of students to access learning resources. Teachers and schools have started producing digital learning resources and they use Internet-based repositories to provide materials to their learners (Hylen, 2006). Nowadays, students consider Google to be the easiest place to start research (Griffiths & Brophy, 2005), use social networks to keep in contacts and exchange materials with peers, and use popular wikis (such as Wikipedia) as the main reference for their study (Dawley, 2009). Universities and schools, on the other hand, have introduced Learning Management Systems (LMS) (such as Moodle and Blackboard) as the primary tool to assemble and deliver learning content rapidly, to collaborate and to promote activities and assessments for their students (Sclater, 2008).

Tablet computers (such as Apple iPad and similar) are revolutionizing the way students approach learning (Jones & Strudler, 2012). If two or three years ago university students used to bring their laptop in classes, nowadays several of them have replaced their laptops with tablets. Students prefer tablets to laptops for their lightness and versatility. Universities and schools are now considering tablets as interesting tools for learning and teaching. Several schools have started small and large projects for the introduction of iPad in schools, and the initial results are very interesting (Hu, 2011, Preciado-Babb, 2012). It's now becoming more and more common to see instructors using tablets for presentations. Moreover, due to the increasing demand of cost reduction and efficiency, these organizations are trying to replace any printed educational resources (handouts, presentation manuals, books, ...) with digital resources. Nowadays, teaching institutions are faced with the problem of managing a large amount of digital resources that often changes through the years. Instructors need an infrastructure for storing and delivering digital materials to their students. Students, on the other side, may take advantage of tablet computers to annotate documents, take personal notes, and share these notes with instructors and peers.

2. ONDIGITA INFRASTRUCTURE

Ondigita is an infrastructure that allows training and educational organization (schools, universities, training departments) to create a digital collection of their educational materials, and allows their students to store and access these resources in their computers, tablets, or mobile phones. Ondigita offers the possibility to easily store all the digital learning materials (books, handouts, presentations, audio, video) in a single course space that is automatically synchronized into the student's mobile device. Materials are always updated and can be synchronized across multiple devices. This way, students always have the most up-to-date version of the digital course archive in their tablet. The mobile device becomes the physical support of all educational materials provided by course instructors.

Thanks to the capabilities offered by the latest tablets, the Ondigita app offers students the possibility to annotate their PDF educational materials. Students will be able to mark up lecture slides, highlight or underline important text passages and add textual notes. An important aspect is the possibility to share annotations: Ondigita enables students and teachers to attach personal multimedia notes that can be shared with others and are synchronized across devices. For instance, a student can attach to a document a voice recording of the instructor explaining a concept, or a link to a website for a more in deep study of a topic. The student can decide whether the multimedia note has to be private or can be shared with peers.

2.1 Integration with External Repositories and Learning Management Systems

Instructors nowadays use different and heterogeneous tools to provide digital materials to their students. Some instructors prefer to use cloud-based infrastructures (Drobox, skydisk, iCloud, …), other use Learning Management Systems (LMS) (if provided by the school), and others simply prefer to send materials via email. Ondigita's approach is to leave the instructor free to use the delivery modality he/she prefers. For this reason, Ondigita has been designed to allow specific adapters to integrate Ondigita with external repositories, such as: LSM (Moodle), Google Drive, Dropbox, email drop, ... This integration will allow teachers to use their preferred modality to deliver materials to their students. Once the teacher uploads a document into a Moodle course or in one of the supported on-line storage service such as Google drive or Dropbox, it will be automatically imported into the specific Ondigita course and converted into the basic format (documents are converted into PDF, video into H.264 standard format, audio into AAC format).

Ondigita is able to synchronize content with Learning Management Systems (LMS) (in particular, Moodle). Learning Managements Systems are very popular and widely employed in schools and universities. Nowadays almost any educational institution uses an LMS to complement and support the activities in the classroom: it is organized like a virtual university in which you can view the course materials, see who is attending the course, provide interactive tools such as quizzes, chat, discussions etc. We implemented a specific adapter for the Moodle LMS. Ondigita is able to automatically fetch the content from a Moodle course and convert it into a basic format. In Moodle, the adapter is implemented as a side block for Moodle courses. The course instructor receives a special pairing key from the Ondigita administrator. Thanks to this key inserted in the block, the instructor creates a connection between a Moodle course and an Ondigita course. In this manner text documents inserted by an instructor in the Moodle course are automatically replicated in the Ondigita course.

The infrastructure (see Figure 1) is structured in the following components:

- A **course materials repository** where all course materials are stored.
- An **application server** provides the basic services to our applications. The application server takes care of converting documents into basic formats, suitable for different devices.
- A **web application** allows institutions to structure their users and courses. Instructors can access the course with their personal account and can use the web interface to upload the learning resources to be delivered to their students. Student can access the web application to manage their account and to access their documents.
- A number of **adapters for external repositories** will be implemented. Thanks to these adapters, teachers can store their resources in other file hosting services (dropbox, google Docs, …) or institutional LMS (Moodle, Blackboard,...) and automatically integrate them into Ondigita infrastructure.

• A **mobile application**, currently available only for Android OS. This app automatically synchronizes the learning resources stored in the repository, and automatically fetches all documents for the courses where the student is enrolled in. It will allow also annotating PDF materials, and taking handwritten notes in personal notepads.

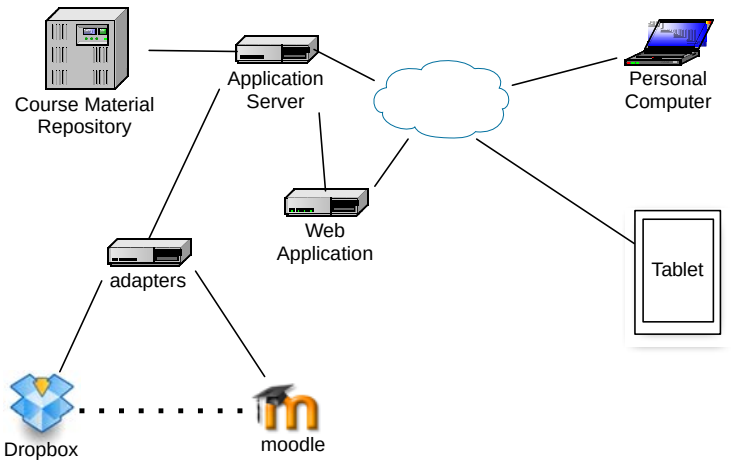

Figure 1. Ondigita infrastructure

3. MOBILE APPLICATION

We implemented a specific app for Android V.4 devices. Currently, this app is not available in the Android marketplace (Google play), since our purpose is to provide the service only to our students. Students have to install the app on the tablet provided by the school and create an Ondigita account through the Ondigita Web application. The android application has a tab-based user interface (see Figure 2) where the students can enroll to courses from a catalog, and browse the courses they are enrolled in. Course content (fetched from a Moodle LMS or from another external repository, or uploaded directly into an Ondigita course by the teacher through a Web interface) is represented by a plain list of PDF files ready to be accessed, studied, and annotated by students.

Course documents in PDF are visualized directly into the mobile app, thanks to the integration of MuPDF, a free software library for rendering high quality anti-aliased graphics. We decided to include this viewer in our application in order to provide the intended document annotation functionalities, namely the possibility to draw lines, to insert drawing object such as rectangles, ovals etc. and insert sticky notes directly into the document. As illustrated in Figure 3, the PDF viewer is integrated with a toolbar that provides such functionalities. Students can tap on one of the icons of the tool to draw the geometric element or to add a sticky note directly on the document. Differently from other PDF annotating tools, such as Adobe acrobat or iAnnotate, Ondigita doesn't insert the note directly into the file, but notes are represented as overlay graphical objects over the PDF document. This technical solution has been adopted for two reasons: first, there is no need to create a new annotated version of the PDF file; secondly, notes are processed as objects that are independent by the PDF document. This solution makes it possible to share annotations across devices and even between peers, and it opens new possibilities of exploitation of the digital device for new advanced functionalities.

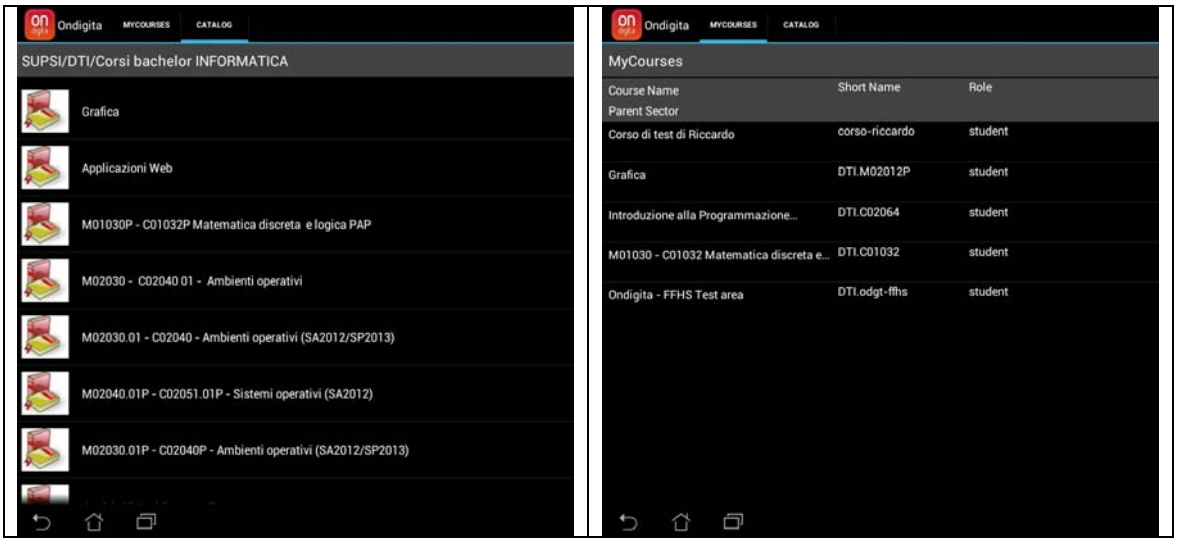

Figure 2. Ondigita mobile app user interfaces for courses. On the left the catalog of courses of the bachelor in computer science, on the right the list of courses the student is enrolled in.

In fact, one of the reasons that have driven us to create Ondigita was to take advantage of the networked device for adding new functionalities that can help students in their learning activities. The possibility to annotate documents and share textual annotations with instructor and peers is considered to be a source of added value by students and instructors alike. The current version of the Ondigita app doesn't allow the sharing of annotations, but we are working towards a new version of the app that allows that functionality and allows the user to define whether a textual annotation has to be kept private or public/shared. In that case, the students, when browsing the document, will see icons denoting textual comments of others. By tapping on the icon, the text of a comment inserted by a peer appears and can be shared if needed. This functionality will be provided in next releases of Ondigita app.

4. FIRST EXPERIENCE OF USAGE

At the beginning of the winter semester in September 2012, all first year students of the bachelor degree in Computer Science have been provided with an ASUS TFT 300 Tablet. In total, about 150 students started using Ondigita to access digital documents that instructors made available through the Moodle platform. About 80 Ondigita courses have been created, and each of them has a corresponding Moodle course. The Ondigita mobile version used by student is a first alpha version of the tool: student cannot share annotations and these are not synchronized with the server, but are saved only on the mobile device.

After about a month of usage, we started collecting first informal feedback by representative of students. We invited two students for each class in a focus group, with the aim of understanding the usage of Ondigita, reporting problems, and collecting needs and ideas for further development. We learned that most students experienced technical difficulties with the device and with the Ondigita app in form of crashes of the application or even of the Android operating system. Document annotation is not very much used for two reasons: (1) due to frequent system crashes, the application is perceived as unreliable; (2) in-class document annotation is not very convenient because of the lack of a keyboard and the impossibility to use a stylus pen to take textual annotations. Students still prefer to take notes on paper, or in some cases even to print out the document and take notes directly on the printed version. However, students expressed a positive opinion on the tool: annotation sharing is a functionality that they want to have, and the note-taking feature has to be easier and close to their needs. Using display keyboard to take notes is inconvenient, complex, and takes too much time. Moreover, very often students want to take notes in a schematic form. A touch keyboard on display is not the ideal tool for that.

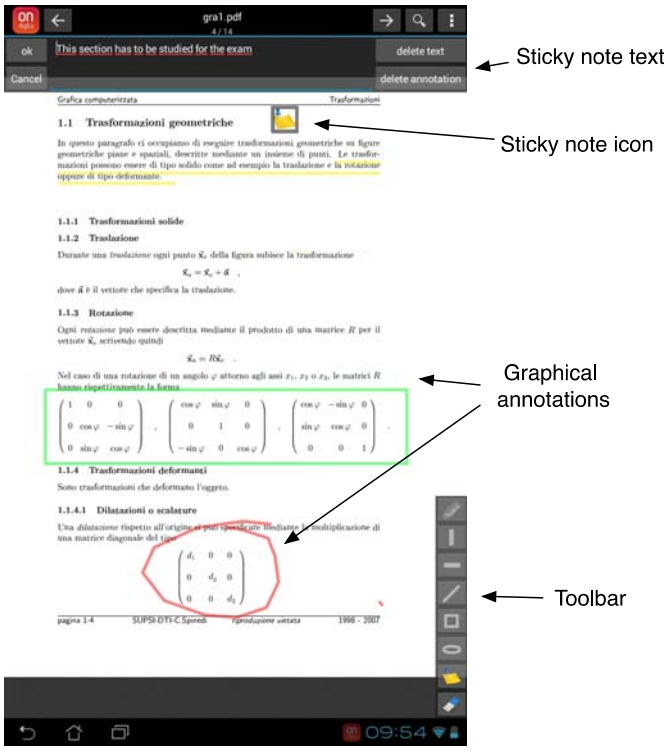

Figure 3. Rendering of a PDF file in Ondigita Mobile Application. Toolbars and digital annotations are visible.

5. CONCLUSION AND FUTURE WORK

We provided our first year student with an Android tablet and an infrastructure that extracts documents from Moodle courses, pushed these documents into students' tablets, and made them available for reading with no need for constant network connectivity. The Ondigita app allows students to annotate PDF documents with drawings, and textual annotations in the form of sticky notes on the document. After a first informal evaluation with some representatives of students after a month of usage, we discovered that tool reliability is a strong prerequisite for being accepted, and students need a flexible tool for note taking that is not limited to a display keyboard. For these reasons, we are working on a new version of the Ondigita application for mobile devices. The new app will allow students to take handwritten notes in a notebook, take multimedia annotations (pictures, audio recording, etc.), and share these notes with peers and instructors.

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Reflection Papers

FROM RADIO, TO SATELLITE, TO MLEARNING: INTERACTIVE DISTANCE EDUCATION IN AUSTRALIA

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ABSTRACT

This paper provides reflections on M-learning as a form of 'distance education', based on a summary of the findings of the Interactive Distance eLearning (IDL) research project in rural and remote Australia under an Australian Research Council Linkage grant. This project was a joint undertaking between 3 government agencies and an information technology service provider. The implementation of the IDL system to replace former School of the Air radio networks which traditionally supported distance education for school students living in remote NSW and the NT began in 2003 and was completed in 2012. IDL provides satellite-supported two-way broadband voice, Internet and one-way video for school age and adult distance education and is moving towards mLearning trials for some delivery centres. The education and training outcomes offer genuine hope to the thousands of participants spread across remote areas of NSW and the NT, allowing them to participate more fully, more meaningfully, and more productively at home, work and in society, despite the tangible difficulties and complexities of living in regional or rural Australia.

KEYWORDS

Remote rural distance interactive elearning

1. INTRODUCTION

Australia is a large continent and is home to some of the most geographically isolated communities in the world. This expanse, whilst central to a sense of place and identity in the Australian psyche (including the majority of Australians who live on the urban coastal fringe), is a source of educational marginalisation for Australian people living in rural and remote areas (Twyford and Crump, 2009).

The New South Wales (NSW) and the Northern Territory (NT) governments - a state and territory, respectively, of Australia - are attempting to address inequities for geographically isolated students by utilising technological advances in information and communications technology. One such initiative is satellite-delivered lessons, or Interactive Distance eLearning (IDL) as it is known, replacing lessons delivered via High Frequency (HF) radio for primary and secondary education. Launched in 2003, IDL has transformed the iconic *Schools of the Air* (SOTA) and improved provision of education services to isolated homesteads and remote Aboriginal communities. In 2009, experimental work was done to make the further shift to mLearning.

The introduction of lessons via radio in 1951 was an innovation of world-renown. But 50 years later the world had changed so much – in rural areas too – and technology advanced so much, that radio was not able to offer the quality of learning that isolated students desired and deserved. The shift from radio-delivered to satellite-delivered lessons, then to mLearning, has been an important development because we are a much more visual society than in the 1950s. Thus, knowledge has shifted from print to multi-media formats, is accessed instantaneously and can be short lived.

Thus, the focus for teaching and learning – not only in distance education – has shifted from students being expected to know content, to students knowing the skills to locate content, using information communication technology (ICT), relevant to the task at hand, and how to judge the worth and applicability of that information. This alone is an important new life-skill. For isolated learners and communities the essence of the change brought about by the introduction of IDL was the opening up of visual communication channels, vastly improved audio, and fast and reliable – in some cases initial – access to the Internet. Teachers can hear their students while students are able to see and hear their teacher and each other.

Using a shared application server controlled by their teacher, students can share applications that are not installed on their own computer. This technology enables students to actively participate and work collaboratively on a variety of tasks. The technology also supports an internal mail feature, the ability to share web links, PowerPoint presentations and other documents, as well as a quiz feature. Much of this can now occur though m-learning, either centrally managed or on a BYOD basis.

2. PROJECT AIMS

The project aim was "through observing IDL/SEP lessons we will develop a better understanding of how students, teachers, parents/tutors and others involved use the technology, what they feel about their engagement, and how these experiences influence their perceptions, satisfaction, behaviours, working practices, learning processes and outcomes." Three key areas were identified to explore these aims:

1. Curriculum: wider range of lesson activity, content and of sources for learning
2. Interactivity: two-way, collaborative learning, sharing work and informal contexts
3. Connectivity: literally and with the class, community and the rest of the world.

To better understand what was happening in IDL lessons the project looked at specific practices and practical differences in order to describe the outcomes through reference to 'activity theory' (Engeström, 1999). This theoretical orientation provided a framework for understanding learning as an activity that is inclusive of the learner and of each learner's knowledge and experiences. This framework also took into account the impact cultural characteristics can have on that learning activity. Data collection included documents, surveys, observations and interviews.

3. FINDINGS

During satellite lessons students share files and applications, visit websites and play educational Internet games. In descending order, IDL tools used during a lesson were IDL software features, Internet searching, word processing, desktop sharing, scanner, email, PowerPoint, audio-editing, multimedia, digital camera, webcam and graphics tablet. Students also use their school intranet site 'blogs' as well as email and a host of other social tools to communicate with each other between and after satellite lessons. Parent/tutor perceptions of the best thing about IDL lessons were:

- It helps them better understand the teacher's expectations of their child and the child to betterunderstand their teacher's expectations.
- The children are able to get together and share work and ideas with teachers and students.
- The children get to talk to their teachers and other students. They know that they're not the only one working.
- Interaction with teacher and classmates – students learn collaborative skills.
- It makes the children feel part of a class and a real school community.

Teachers explained the empowering factor was technology's ability to enhance interaction with peers, teachers and the topic.

[IDL] enhances our student/teacher relationship. [As teachers] we can meet outcomes and teach content more explicitly by making learning meaningful. The students are active participants in their own learning. It's great to be in such a challenging work environment!

An early finding was how parents and families feel less 'remote', not only for education, as access to the world-wide web allowed families to stay closer in touch with government initiatives and changes to policies and curriculum, as well as to explore – easily and quickly – educational issues around the world.

This new capacity for families to engage not only with their school but also the wider world was linked, anecdotally, to improved motivational effects on all ages regardless of socio-economic status and race. It also led to parents/tutors feeling more confident in supporting their child's learning.

Embarking on such a complex research project, we needed to be confident that we were looking for the right things in our three themes, as listed above. One student wrote in her survey response what we interpreted as a tidy summary of our hypothesised outcomes when she explained that, "… I gain positive practical skills [curriculum], a feeling of being included in the community [connectivity], and instant

interaction with others over a long distance [interactivity]." These three outcomes are occurring because the technology assists teachers to design activities that grab students' attention.

It is important to recognise that, in achieving what this student describes, teachers worked hard to create the feeling that they are in the same room with their students despite being scattered over as much as a million square kilometres. The experience is an example of authentic learning, where there is a 'live' feed to the class and it is demonstrably interactive and relational, not only teacher directed or transmitting knowledge down to the students. The result of having vision, being this engaged and interacting in real time was that, as one teacher put it, students became 'addicted' to the lessons. Outcomes for school age and adult VET students studying via IDL that can be discerned in our data include:

- Better quality distance education through access to real-time live satellite lessons; that is, teachers have created living classrooms.
- More detailed and varied content in satellite-based lesson material and activities, especially for subjects with substantial practical components such as beauty skills and commercial cookery.
- Customised courses designed to cater for specific rural and remote community needs.
- Higher levels of engagement in lessons through an array of computer-based programs, tools and applications being available for teachers and students to increase interactivity and connectivity in the lesson.
- People better prepared for employment and/or further study in a way not possible before the introduction of IDL.
- Enhancing the skills base of parents to assist their children studying with a SOTA/DEC.
- An increase in digital literacy.
- Greater connectedness locally and globally through enhancing communication channels and access to countless experiences and sources of knowledge only available through the worldwide web.

4. THE FUTURE OF IDL

The IDL program has allowed schooling to be done differently and better for hundreds of individuals and scores of communities that were significantly deprived of access to education and training because of where they live, before satellite delivery was provided. IDL offers real and tangible hope to these people and communities as they gain qualifications and skills only able to be dreamt of beforehand. IDL is also informing the shift to ICT in mainstream classrooms, as a senior education departmental figure explained:

I believe the work that's happened in this project has influenced policy and thinking around how students learn; that students can be collective learners, they do not need to be in the same place to learn (…) it I isn't [just] a 'solution' for distance education; it's a way of connecting [any] learners.

One key conclusion from all participants was teaching practices need to develop alongside technological changes. Interactive distance elearning is a fluid and dynamic environment and these expectations and evolutions are a challenge to all involved in its future. Changes related to M-learning include the ability to adopt and adapt social media and technology, ready-to-hand, web-enabled mobile phones and tablets, that provide students of all ages with 24/7 access to learning resources and are underpinned by sound learning theory principles. IT applications are only as good as the user, and only any good if the user can access them over a reliable, fast and inexpensive network.

For education and training, with expectations of multi-tasking, strong overlap between personal and education use of technology, active engagement on one's own learning, and – especially for those who have grown up 'digital', customisation is crucial, as well as collaboration, innovation and, finally, fun! M-Learning offers the opportunity for distance education to combine content and modes of delivery n a way that also mergers local with global, and this reduces the learners reliance on the teacher(s). The only qualification is that m-learning remains a high cost option for young people, the very generation that can benefit most. Governments as well as private business need to find a solution, and fast.

5. LESSONS FOR POLICY AND PRACTICE

The vast majority of participants in this study were enthusiastic, involved, committed, hardy and innovative, whether in the IDL leadership and management level, teaching in the studio, at the other end (homestead or community school) or other role and location. In this context, people come and go, sometimes without bringing to completion what they set out to do. This is part and parcel of living and working in regional Australia. In the three years since the ARC "Opening our Eyes" research project began there are few original staff still active in IDL – yet the pioneering spirit prevails. The rollout and successful implementation of IDL would never have happened without the energy, focus and determination of all those who contributed, not only to our study. The participants in IDL have been an exemplar of what Wenger calls a 'community of practice'; that is, where a group of people share a passion for something they know how to do and interact regularly to learn how to do it better.

6. REFLECTIONS

What needs researching now is how most people's first interaction with the internet will be on mobile devices, and on a global scale (e.g., Somalia's excellent 3G network despite the country's political disruption). Governments and service providers need to transition to working our how this will impact 'distance education' for whole populations, through asking how to provide people with real educational opportunities when all they have is a low-grade mobile phone. Future research topics and issues include: What are the subsequent consequences for distance pedagogy? What opportunities could this bring and what challenges will people face? How can mLearning be a real world (and therefore, word) bringing about positive change for those learning remotely so they can leverage this newfound advantage?

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FLIPPED APPROACH TO MOBILE ASSISTED LANGUAGE LEARNING

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ABSTRACT

There are abundant possibilities for using smart phones and tablet computers for foreign language learning. However, if there is an emphasis on memorization or on technology, language learners may not develop proficiency in their target language. Therefore, language teachers should be familiar with strategies for facilitating creative communications. The focus should be on how learners use the content, rather than content delivery through technology. This paper will combine American Council on the Teaching of Foreign Language (ACTFL) proficiency guidelines, pedagogies to promote language proficiency, and the idea of a flipped classroom to conceptualize the use of mobile technology applications to promote proficiency among language learners.

KEYWORDS

Mobile Assisted Language Learning (MALL), flipped classroom, ACTFL proficiency guidelines, authentic learning, task-based learning

1. INTRODUCTION

Mobile Assisted Language Learning (MALL) has been a topic of interest among foreign language instructors (Alemi, Reza Anani Sarab, & Lari, 2012; Saran, Seferoglu & Cagiltay, 2009; Wong, Chen, & Jan, 2012; Wong & Looi, 2010), especially since high school and college students now commonly own smart phones and tablets. Moreover, there is an abundance of mobile apps specifically designed for language learning. However, over-dependency in content-delivery and apps has the potential to force learners to spend most of their time focused on memorization rather than language creation. It is necessary to build instruction around how learners interact with others and negotiate meaning in authentic communication (Schinke-Llano & Vicars, 1993; Shekary & Tahririan, 2006). Hence, all language instructors need to have a firm understanding of how learners develop proficiency in the target languages prior to making the decision to use mobile technology in their classrooms.

The purpose of this paper is to connect a pedagogical framework of language learning to the idea of a flipped classroom. The flipped classroom concept is already accepted for science and math education and has the potential for success in foreign language instruction. In a flipped model, students learn content as homework, then use their knowledge for real-life problem solving and projects (Lage, Platt, & Treglia, 2000; Sams & Bergman 2011). A teacher can facilitate a real purpose for communication and assist their learners in interaction with native speakers through digital communication. This paper will suggest a flipped model for MALL.

1.1 Language Proficiency

There has been an enthusiasm for delivering content through mobile devices so that learners can study anywhere and at anytime. Some MALL researchers focus on delivering vocabulary and pronunciation through mobile devises (Alemi, Reza Anani Sareb, & Lari, 2012; Saran, Seferoglu, & Cagiltay, 2009). However, language proficiency is determined not by what learners know, but instead by what learners can do. In other words, dynamic performance is the main focus rather than static knowledge. Therefore, how the learners use the vocabulary and pronunciation that they learn in open-ended communication, requires further

investigation. The most referenced guidelines for foreign language proficiency in the United States are authored by the American Council on the Teaching of Foreign Languages (ACTFL). These guidelines are divided into distinguished, superior, advanced, intermediate, and novice, and are used in conjunction with the National Standards for Foreign Language Learning. The distinguished speakers can hypothesize, advocate a point of view, and adjust their speech according to an audience. Superior speakers can talk about a variety of topics in formal or informal settings. They can also present their opinion on a wide range of issues. Advanced speakers speak in past, present, and future tenses utilizing paragraphs. They can be understood by native speakers who have limited exposure to non-native speech. Intermediate speakers can combine learned materials for personal communication. They can be understood by native speakers who are accustomed to non-native speech. Novice speakers can communicate using memorized materials in highly predictable situations (ACTFL, 2012).

2. APPLICATIONS OF MOBILE TECHNOLOGY THAT PROMOTE LANGUAGE PROFICIENCY

2.1 Pedagogy for Language Learning

2.1.1 Beyond 'Anywhere, Anytime' Input

Mobile phones allow students to study pronunciation and vocabulary anywhere they go, and students seem to benefit from this feature (Saran, Seferoglu, & Cagiltay, 2009). Such a report has the potential to make language educators enthusiastic about MALL. Nonetheless, one should not ignore the negative side of mobile technology use, instead they should try to minimize potential drawbacks. For example, mobile phones can provide stimuli that cause students to waste time, rather than to study. Lu (2008) reported that a student who was curious about new words and intentionally used new words retained vocabulary better than the one who could not resist playing a game every time he picked up a mobile phone. Hence, instructors must know their learners first, and think of a variety of ways to make learning enjoyable. For example, if new words were presented first, and then embedded in an interesting story and delivered daily in a small segment, it would be possible to entice more learners to read or listen to the contents.

Presenting vocabulary in a story is not only good for motivation, but it is also effective for retention. There are two types of vocabulary learning: incidental, in which learners figure out the meaning of words in a context while reading, and intentional, learning without context and dependent on memory (Ahmed, 2011; Derakhshan & Khodabakhshzadeh, 2011). Vocabulary is retained better when both incidental and intentional learning are utilized. In addition, the focus of MALL should not only be on input, but also on learners' output (Anthony, 2008; Li, 2012) and interaction (Ryoo, 2009). Learners need to create their own sentences in order to move from the novice to the intermediate level. Language learners need an environment and feedback in which to communicate their ideas on both concrete and abstract topics.

2.1.2 Task-based Language Learning

Application of language to a task that exists in real life allows learners to use the target language in a meaningful manner. For authentic language creation to occur, learners need a reason to communicate. A mobile device can facilitate interaction after an authentic task is created (Tai, 2012). For instance, understanding authentic material, or material made for a native speaker, is a task that allows learners to make sense of their real environment. Moreover, learners are actively engaged when they describe their experiences and environment using their target language. Use of mobile tools allows them to go outside of their classroom (Wong & Looi, 2010). When language learners communicate their thoughts and ideas through a digital device with native speakers, they find a purpose for studying the target language. This author suggests that learners' interests and abilities should be reflected in instructional design. For example, if learners are interested in food, they can first learn the vocabulary words for food and cooking. They can then research a new recipe and create a cooking show video so that they will have an opportunity to use the target language.

2.2 Flipped Classroom

A flipped classroom is a format in which students learn necessary contents at home and apply the knowledge in the classroom (Tucker, 2012). Students report to the class with the knowledge needed for application. This format allows the instructor to adjust the in-class exercises to students' learning styles (Lage, Platt, & Treglia, 2000) because students can receive individualized attention (Rycik, 2012). Students are responsible for solving problems during the class. Some students, who are more passive learners, may resist this model. Hence, the teachers who implement this model need to set up clear expectations for students that require them to take ownership of their learning process. The students are able to participate in activities only if they watch important content videos prior to reporting to class (Sams & Bergman, 2011).

2.3 Combining Language Learning Pedagogy and the Flipped Classroom Model

A flipped classroom approach has a potential to make language instruction more effective. Learners can report to the class with the vocabulary, grammar, and pronunciation already learned. They can use the language to communicate ideas, with their teacher's assistance, during the class. One might argue that learners could use the target language on their own through *YouTube*, *Twitter*, and other means to interact with native speakers. Language learners may choose to use the target language on their own and it may have impact on their proficiency. A possible drawback is that when the quality of input and interaction is not controlled, social interaction through technology does not always result in successful language learning (Bahrani & Sim, 2012). Therefore, quality control can be time consuming for teachers.

Below are some ideas for flipping a foreign language classroom.

- Have students learn family vocabulary and practice pronunciation prior to reporting to a class. There are language learning apps such as *Essentials* and free dictionaries. Ask students to take pictures of the family members with their phones and bring them to the class. During the class, students can use tools such as *PicCollage* or *Glog* to create a visual to show their families. The students can show visuals to their classmates to present about their families in the target language.
- Students watch a music video via *YouTube* as homework. For example, students in the United States studying Spanish may view Los Yonic's *Quinceanera*. During the class, students will discuss cultural perspectives, starting with questions such as "Why does this song repeatedly mention challenges in life?" and "What seems to be a difference between Quniceanera in Mexico and Sweet 16 in the United States?"
- Prior to the class, students practice dialogues with *Hello-Hello*. During the class, a teacher can set up slightly different contexts with the dialogue. The students engage in impromptu conversations.
- Students practice past tense prior to the class. They will also read a folktale making use of the target grammar in past tense. During the class, the teacher will present picture prompts for a folktale. Students will write the story in their own words.
- Students in a Japanese class watch a lecture video about "..ga hoshii" (I want) and "… tai" (I want to do) form as a homework. During the class, they watch a short video clip of *Doraemon*, an animation about a cat robot that grants one's wishes. As the post-viewing activity, they discuss things that characters in the animation want, or activities they want to do. Students will also read *Doraemon* in manga (Japanese comic) format. Then, they make their own manga about what they would ask *Doraemon* to give them. Finally, they will share their manga with native speakers.

3. CONCLUSION

In this paper, the author suggested ways for flipping a classroom using while mobile technology so that learners will have opportunities to engage in meaningful communication using their target languages. Since language creation is a condition required for the development of language proficiency, spending most of the class time in language output, interaction, and receiving feedback is recommended. A limitation of this paper is that this idea has not been tested and researched in a foreign language classroom. Another limitation is that this paper did not mention security and privacy issues that instructors need to understand. In addition, this

paper did not discuss how the students will develop the ability to evaluate the quality of input. For example, students are likely to be exposed to low-quality writings by native speakers when they read responses to a *YouTube* video, which language learners need to know not to mimic. Despite these limitations, this paper suggested pathways for foreign language teachers to flip their classrooms while utilizing their students' mobile devices.

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MOBILE PEDAGOGY

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ABSTRACT

How can higher education leverage information technology to address the importance of social and geographical context in learning? This reflection paper begins with a review of the literature on learning technologies to identify the key questions of study. Building upon the missing links of pedagogy, context and process, the author proposes an alternative view of how academia can integrate what mobility has to offer. This contribution concludes with a vision of "mobile pedagogy" that underpins his current work in management education.

KEYWORDS

Mobility, Pedagogy, Learning Technologies, Management Education, m-learning

1. INTRODUCTION

Mobile pedagogy embodies a defining set of principles and methods that leverage social and geographical context in learning. Mobile pedagogy can potentially play a critical role in designing management education in encouraging students to appropriate the learning agenda, to transform classroom knowledge into usable competencies, and to elucidate and harness the power of professional networks. To reach this potential, advocates of mobile technologies will need to propose clear answers concerning its place inside, or along side, the core concepts of pedagogy.

Professional opinions diverge significantly concerning the impact of mobile technologies in learning. Four short years ago, Livingston (2009) noted that the near universal use of mobile phones among university students has had little to no impact on educational experiences and services. Earlier this year, Proulx (2012) suggested that universities are at a tipping point on which internet technologies have dramatically challenged the very nature of the classroom. Before commending or condoning either point of view, it is important to gauge the challenges and potential advantages of mobile technologies for students, instructors and institutions of higher education.

This "Reflection" paper explores the place of mobile pedagogy in the field of higher education. The work addresses four current challenges:

– How can we operationally define "mobile pedagogy"?
– How do current technologies leverage this concept?
– In what ways has this vision challenged the traditional processes of higher education?
– Which concepts and principles can enhance the value of this practice in the future?

We will begin with a review of current research on learning technologies to identify the key questions of study. We will then turn our attention to an alternative view of how pedagogy can refocus on what mobility has to offer. We will conclude with the tenets of our vision of "mobility pedagogy" that underpin the development of our AMATE™ platform as an interactive support for management education.

2. RESEARCH THEMES

If scholarly work on the use of mobile learning has not revolutionized the use of technology in education, it has contributed to our understanding of how IT can support the learning process. A quick review of research over the last two decades draws our attention to how mobile technologies have been used in support

distance, blended and/or course room education, how IT have shaped higher education, and how they reflect deeper "realities" of our social cultural systems.

Learning technologies are designed to support learning through the creation, deployment and management of appropriate technological processes and resources.[i] One central theme in the literature to date centers on the role of mobile technologies in the classroom. Kadirire (2009) defines mobile learning as a form of e-Learning which takes place anytime, anywhere with the help of a mobile device. Keskin and Metcalf (2011) note the example of MoLoNET that studied "the exploitation of ubiquitous handheld technologies...to facilitate, support and extend the reach of teaching and learning".

The major challenge facing this line of reasoning is identifying exactly which processes and resources mobile technologies are designed to support. As many authors have argued, it is difficult to identify where learning starts and ends. Walker (2006) points out that mobile learning is not about anytime, anywhere access but about learning perpetually and across contexts. Chan et al. (2006) suggest that the concept of seamless learning might be more appropriate to describe learning processes in which learners use mobile devices to navigate from context to another. Traxler (2007) concludes that the impact of mobile technologies could be better understood by focusing on taxonomy of use scenarios: technology driven mobile learning, portable e-learning, connected classroom learning, situated mobile learning, mobile training and remote mobile learning.

A second specific research theme, exemplified by Engestrom (1996), proposes that mobile devices are simply another example of how information technologies have shaped the contours of education. Textbooks, computers, and video equipment have historically both supported and defined the limits and possibilities of class and the classroom. Learning technologies today incorporate software, hardware, and Internet applications like wikis, blogs and social media. As a whole, information technologies have permitted the development of personalized learning styles, learning designs, and blended learning. How will the introduction of mobile phones in the classroom impact learning objectives and outcomes?

The precursors of mobile learning suggested the possibilities of mass personalization in distinct learning spaces mediated by hand-held devices. Norris & Soloway (2002) question the foundation of this "1:1" vision, pointing out that learners rely on a variety of technologies to support their learning styles. In the last decade, the notion of "seamless learning" has gained in popularity; mobile devices function as interfaces between learners and their different learning environments (Bentley, Shegunshi, & Scannell, 2010). ong (2012) advocates revising the notion of a personal ‘learning hub’ independently of one mobile device: each learner's profile can be stored and developed on a cloud based, device-independent learning platform.

A third research perspective has explored to what extent learning technologies have mirrored the broader foundations of dominant social cultural systems. Authors argue here that the introduction of technologies in the classroom is far from neutral; information technologies have simply reinforced the traditional views of control, context and communication that learning represents. Sharples (2005) underlines the over-riding concern with control: traditional learning technologies are most often designed around a specific curriculum to reach the professor's teaching objectives. Parsons et al. (2011) suggests that, far from decontextualizing education, learning technologies introduce context as a shell that reinforces the images of foundations of formal education. In this view, communication remains channeled between that of the instructor (whether it a real life or virtual professor) and the students that are largely shielded from the contradictions and uncertainty of the real world.

Other researchers have explored the dimensions of learning communities (e.g., MacGregor, Tinto, & Lindbald, 2001) and the interdependence of individual and collaborative learning (e.g., Kazmer, 2005; Skop, 2008). Yu (2007) suggests that the literature on mobile learning initially focused on transferring learning content onto mobile devices, a second generation focused on pedagogical, while the third generation explores the use of context-aware technology. Wong (2011) argues that mobile learning has tended to confine learners within the context of formal learning (teacher- or expert-planned learning materials or activities), whereas new insight can be gained in exploring how mobile learning stitches together the students' formal and informal learning in personalized learning experiences.

3. THE MISSING LINKS - PEDAGOGY, CONTEXT AND CONVERSATION

This discussion of learning, technology, and culture has neglected a number of questions that could enhance our appreciation of the subject at hand. What is the link between learning technologies and pedagogy? Can we talk about mobile learning without exploring the pedagogical implications on both teaching and the institution? Can or should pedagogy be decontextualized? How do mobile applications capture context, and how will this shape mobile pedagogy? Would mobile pedagogy be more relevant in suggesting that learning itself has become mobile?

Pedagogy

What do we mean when we refer to the importance of pedagogy? Formal definitions of the subject evoke the science, art or profession of teaching. The fundamental objectives of pedagogy entail the development of the human being, or at least the acquisition of clearly identifiable knowledge, skills or competencies. Obtaining these objectives requires elucidating the learning processes within which professors, students, and the technologies interact. Does mobile pedagogy refer to simply changing the technologies, or how technologies shape pedagogical context, processes and participants?

Park (2011) concludes that mobile applications have rarely been founded in established pedagogical theory. Trans-actional distance theory, as exposed by Moore (1997), provides one potential theoretical foundation in proposing that virtual communication is a form of self-action and inter-action. Jonassen (2000) claims that activity theory could provide a powerful framework for designing student-centered learning environments. Naismith et al. (2004) suggest that mobile practices can be explored through various paradigms including behavioralist, constructivist, situated and collaborative. Kang and Gyorke (2008) underline the insight of cultural-historical activity theory (CHAT), which suggests that artifacts, including language and technology, mediate the social aspects of human activity.

Context

University courses are often modern day examples of the Aristotelian unities reflecting strict applications of the harmony of time, place and action. If courses are building blocks of higher education, courses are built of classrooms, classes, professors and students. Class refers to a group of students who meet at a regularly scheduled time to study the same subject, and usually implies that they are taught together. A professor is literally a "person who professes", an expert in the arts or sciences, a teacher of high rank.[ii] In between the professors and students are a number of fine examples of technology: podiums, desks, pointers, and increasingly, information technology.

All activity is performed in both geographical and social context. Cole (1996) makes an important distinction between context as “that which surrounds us” and context as “that which weaves together”. Learning thus not only occurs in a context, it also creates context through continual interaction. This duality exists in mobile learning between the student's learning environment and the context arising out of the constructive interaction between student and technology. This vision situates the learner inside a filtered "shield" in which the senses receive "meaningful" data. These contexts can be elucidated from the myriad of data within a student's reach in a number of ways: creating a supportive workspace, forming ad hoc social networks, or fostering meaningful conversation.

Conversation

When we introduce the notion of mobile pedagogy, we suggest that learning has more to do with how we capture context than how we design technology. The challenge in higher education today is that our context is increasingly mobile, regardless of the technology at hand. The foundations of learning are continually shifting as we move from one location to another, deploy new resources, and enter new conversations (Lonsdale et al., 2004, Sharples, 2005). Learning is not a neat transfer of information, but a complex and often-chaordic network of technology intermediated human relationships (Russell 2002). Professors are no longer the sole custodians of knowledge, the learning agenda focuses increasingly on conversation itself.

Education can be thought of as a directed, continual conversation. *Directed* in that education presupposes clearly defined learning outcomes for both the class and the students. *Continual* in that the learning experience neither starts, not stops, when the student enters the classroom. Pedagogy offers us the opportunity to structure and to enrich the language that ties each student to the context in which they work. As such, both the classroom and the professor shape the direction and the boundaries of conversation. Can we speak of mobile pedagogy without speaking of classrooms, instructors and content? The use of mobile

technologies offers academia an opportunity to extend the conversation, it offers a new way to experience, interact, and dialogue. It is not any more or less virtual than the University itself, it is a complementary avenue to understand context through conversation.

4. MOBILE PEDAGOGY

Information technologies can provide virtual windows through which students can view the realities of social behavior. Mobile interfaces can become platforms designed to enrich the interactions between those that produce information on one hand and those that consume it on the other. The ability of mobile technologies to capture both geographical and social context can offer students a filtering device to focus on the specificities of organizational dynamics. Realizing this potential has guided our own efforts in the AMATE™ platform for management education. [iii]

The AMATE™ platform integrates a number of design principles to bring both substance and structure to the concept of mobile pedagogy. We believe that mobile content should be consumable rather than exhaustive, keyed to students' study habits than to the standards of academic writing. Pedagogical content here is keyed to real world situations: the instructional design incorporates workbooks, games, and simulations that take advantage of mobile technologies unique set of functions and features. Continuous evaluation exercises are built into each support, reflecting both a student's previous work and community input. Taken together, we believe these principles provide a solid foundation for building a case for mobile pedagogy.

To conclude this "reflection paper", we will explore the tenets of this vision of "mobility pedagogy" in more detail. We suggest that mobile pedagogy should be consumable, and as such, educational content should take into account the study habits of the vast majority of students today. Reading habits have changed as the digital delivery of data, information and scholarly work has become increasingly prevalent. Graphics and video compete with the written word to inform and organize students' understanding of the world around them. The need to facilitate discovery of meaningful content has become a critical objective of higher education as information overload has become synonymous with the Internet Economy itself. In structuring and restituting content through transmedia authorship we can provide a key piece in the larger picture of pedagogy today.

In proposing that mobile pedagogy be applicable, we are implying that instructional design can integrate interactive workshop exercises, games, simulations alongside the subject of study to help students apply the content to the realities of their own professional challenges. The principles of activity theory, illustrating educational principles with experience, actions and practice can be implemented profitably on mobile devices. Student work, as well as instructor input, can be accessed anywhere, anytime and on interface. Feedback, not only from course instructors, but also from peers and subject experts, becomes a core principle of mobile pedagogy.

By integrating continuous evaluation into mobile pedagogy itself, we are proposing that institutions and faculty can use the unique characteristics of mobile devices to help students better situate progress towards education goals. The ability to transmit and then store student input on the "Cloud" allows students to both compare their results over time and to compare their results with the aggregates of target communities. Institutions can study the aggregate data themselves to get a better handle on the objectives, behaviors and outcomes of students over time. The ability to recall the data on demand can also be leveraged in teacher/student interviews in class or from a distance.

Learning becomes a truly social activity, where students can draw on the experience, suggestions, and proposals of their colleagues. Students demonstrate daily their affinity for their telephones, micro-messaging services, social media, and video archives. Mobile pedagogy can potentially harness these "intuitive" communication channels to enrich and extend class discussions as students talk to other students. Mobile devices can not only host these apps, but also capture the content that stimulated the desire to communicate. Mobile pedagogy can thus take into account student behavior, not just their outputs. Higher education institutions can glean invaluable data on how student and faculty interactions shape the learning process.

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[iii] AMATE™ is a social book publishing platform developed for management education. We are currently beta-testing the platform this year in two international IT companies, two business schools, and with four general public management titles.

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CONTEXT AND CONCEPTS IN MOBILE LEARNING

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ABSTRACT

This reflective paper discusses the contextual and situated character of concepts in mobile learning. It aims at challenging current conceptualizations of mobile learning by utilizing ideas from pragmatist and socio-cultural perspectives. This challenge includes a framework that embraces a distinction between interactional and transactional world-views. The paper suggests a dynamic non-dualistic view of mobile learning. This view includes examples of concepts that might be appropriate for conceptualizations of mobile learning.

KEYWORDS

Conceptualization, context, mobile learning, participation, pragmatism, socio-cultural perspective

1. INTRODUCTION

In a well-quoted paper by Traxler (2007) it is claimed that a conceptualization of mobile learning must recognize that it "is essentially personal, contextual and situated" (p. 1). This idea of conceptualization also appears in recently published papers within the field of mobile learning, e.g., in discussions of contexts and seamless learning (e.g., Milrad et al., Forthcoming; Sharples et al., 2012; Traxler, 2012). Nevertheless, this reflective paper will try to challenge the current interpretation of the personal, contextual, and situated character of mobile learning by addressing some of its philosophical ideas. In this challenge, the paper applies a theoretical framework consisting of interactional and transactional world-views. It suggests that a chosen world-view has consequences for which concepts are suitable to apply if a coherent understanding of mobile learning is sought. In particular, this discussion relates to mobile learning and its inherited contextual and situated character. While some concepts, e.g., interaction, more clearly link to interactional world-views, this challenge also concerns the current use of concepts. Influenced by ideas taken from the pragmatist and socio-cultural perspectives this paper suggests that mobile learning is a dynamic and ecological phenomenon built on transactional ideas of human action (see Jaldemark, 2010, 2012). The rest of this paper starts with a discussion of the relation between mobile learning and the environment. From this discussion follow consequences for how to understand the relation between context and the environment. Finally, the paper concludes by suggesting suitable concepts for a transactional understanding of mobile learning.

1.1 Mobile Learning and the Environment

Some of the most influential papers in the field of mobile learning link to ideas presented by Dewey (1916) and Vygotsky (1978). These two scholars are without a doubt among the most influential within the pragmatist and socio-cultural perspectives. They both had a big impact on later development within educational theory. Among the works of scholars within the field of mobile learning (e.g., Hwang, Yang, Tsai, & Yang, 2009; Pachler, Bachmair, & Cook, 2009; Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009; Sharples, Taylor, & Vavoula, 2007; Zurita & Nussbaum, 2007), papers are found that link their work either to Dewey and Vygotsky or successors such as Engeström (1987) or Lave and Wenger (1991). However, if we start to investigate mobile learning based on the ideas originally discussed by Dewey and Vygotsky, how can these studies be understood, and how can some of the most vital concepts of mobile learning be understood?

To start this discussion, we have to start with the ontological question of the relation between the human being and the surrounding environment. From a philosophical perspective, at least three positions have

unfolded over time. One of them, the idealist position, discussed by Plato, among others, emphasizes the minds of human beings as the location where the real world exists. The surrounding environment is just a shadow world, a pale version of the real world that exists in the mind. The second position, empiricism, popularized by Francis Bacon in the 17th century, among others, emphasize the minds of human beings as a separate mental world that is subject to the influence of external experiences. Both of these positions make dualistic claims that include a strong separation between mind, body, and environment.

Dewey (1916) and other scholars within the pragmatist movement rejected these dualistic positions. According to Dewey, this position isolates people from each other and the communities in which they exist. This means that physical and social aspects of the environment are important for understanding human beings. Human action is a part of this environment and a condition for the emergence of "a mind of his own" (Dewey, 1916, p. 344). Dewey discussed the inseparability between the human mind and the surrounding environment by claiming that "the self achieves mind in the degree in which knowledge of things is incarnate in the life about him; the self is not a separate mind building up knowledge anew on its own account" (p. 344).

Simultaneously, scholars within the socio-cultural movement in Russia raised similar thoughts about the inseparability of man and the surrounding environment. Building on Marxist ideas, Bakhtin and Vygotsky emphasized the cultural, historical, and social transformations that occur through human activity. In the 1930s, Vygotsky (1978, p. 60) claimed that "the influence of nature on man, asserts that man, in turn, affects nature and creates through his changes in nature new natural conditions for his existence". In other words, living is a dynamic and ecological phenomenon of being a part of the cultural, historical, and social patterning of the world. Bakhtin (1935/1981) emphasized the relation between man and the surrounding environment in terms of humankind's constant dialogue with the world. In short, he argued that human understanding is an intertwining of responses in dialogues. He claimed that understanding and response dialectically merge "and mutually condition each other; one is impossible without the other" (p. 282).

In the mobile learning literature, it is popular to emphasize the strong relationship between mobile learners and the surrounding environment (e.g., Milrad et al., Forthcoming; Sharples et al., 2007; Traxler, 2007, 2012). Often such discussions are held in terms of context. For example, Milrad et al. (Forthcoming) claims that "cross-contextual learning can enable a continuous learning experience across different settings, such as home-school, or workplace-college", Also Sharples et al. (2007, p. 225) discuss context by claiming that it should be seen "not as a fixed shell surrounding the learner, but as a construct that is shaped by continuously negotiated dialogue between people and technology". Such dynamic ideas of the relation between mobile learners and context follow in the footsteps of the world-views of the pragmatist and sociocultural perspectives discussed above.

A conclusion drawn from ideas discussed by these scholars is that human beings can be understood as inseparable from the surrounding environment. Moreover, a dynamic and ecological non-dualistic position can be applied in conceptualizations of mobile learning. However, if we take this position and follow in the footsteps of Dewey and Vygotsky, two consequences for conceptualizations of context in mobile learning follow. First, we need a conceptualization of contexts that includes the relation between learners and the environment. Second, such concepts should embrace the inseparability between learners and the surrounding environment. In the next section, a deeper look at these issues will follow. Below, this paper interprets these claims through a framework consisting of interactional and transactional world-views (Altman & Rogoff, 1991; Dewey & Bentley, 1949/1960).

2. CONTEXT AND THE ENVIRONMENT

According to Dewey and Bentley (1949/1960), the understanding of context and situations, in terms of the relation between man and the environment, relates to a distinction between interactional and transactional world-views. A choice between these world-views gives different answers to conceptualizations of context in mobile learning. According to interactional world-views, e.g., empiricist or idealist positions, context in mobile learning is a rather uncomplicated phenomenon. While interactional world-views are derived from the ideas of Newton, and the laws of motion where "action and reaction are equal and opposite" (Dewey & Bentley, 1949/1960, p. 68), human action and its context is a system that is treated as a phenomenon that involves particles, boundaries, and different laws of effect. In such a system, contextualized human action is

fragmentized and seen as a reaction to the preceding action. Therefore, in this distinction, interactional world-views can demarcate human action in a particular context from other contexts. However, Dewey and Bentley (1949/1960) claimed that such a dualistic view is a disadvantage for inquiry regarding human action, such as participation in mobile learning, while it "shatters the subjectmatter into fragments in advance of inquiry and thus destroys instead of furthering comprehensive observations for it" (p. 68). Interactional world-views are dualistic when they separate human beings and their minds from the surrounding environment. Such a world-view makes it possible to understand participation in mobile learning without reference to the conditions of the surrounding contextual features. Learners might be discussed in a narrow sense in terms of being separated from the surrounding environment, and aspects of time and space might be deemphasized. As a consequence, an interactional world-view can support the idea of a separation between offline and online participation. In fact, they can be understood as two separate phenomena. Nevertheless, such a world-view seems to be hard to link to the contextual claims of some of the leading scholars in the field of mobile learning (e.g., Milrad et al., Forthcoming; Sharples et al., 2007; Traxler, 2007). Instead, they emphasize a complex relation between aspects of context, human action, and technologies.

From an interactional world-view, one conceptual consequence for understanding mobile learning is that applied concepts do not necessarily need to have an intersectional character. In short, concepts need to take into account the fact that mobile learning is about processes of action and re-action. Such an approach might be useful if mobile learning is discussed solely from a narrow perspective, as in the case of a technological phenomenon that denies the consequences of learners' experiences and feelings. However, such definitions of mobile learning "are constraining, techno-centric, and tied to current technological instantiations" (Traxler, 2007, p. 4). The dualism of such world-views is problematic as "epistemologies that isolate two components, that set them up separately and then endeavor to put them together again, fail" (Dewey & Bentley, 1949/1960, pp. 151-152). Following the claims of Dewey and Bentley, an interactional world-view excludes a coherent dynamic and ecological understanding of mobile learning contexts as a nexus between learners' participation in multiple settings. Nevertheless, such a world-view might be applicable for demarcated dualistic conceptualizations of mobile learning. Such demarcated understandings are the issue of challenge in this paper. However, the idea of conceptualization in this paper follows the idea that participation in mobile learning is a complex, cross-contextual, and boundless phenomenon. Such a conceptualization can be achieved in applications of a transactional world-view.

Transactional world-views are dynamic and ecological and reach across time and space. Such world-views comprise "the right to see together, extensionally and durationally, much that is talked about conventionally as if it were composed of irreconcilable separates" (Dewey & Bentley, 1949/1960, p. 69). Discussing mobile learning in terms of transactions incorporates a non-dualistic view of human action in terms such that "there are no separate elements … the whole is composed of inseparable aspects that simultaneously and conjointly define the whole" (Altman & Rogoff, 1991, p. 24). It also focuses on situations that arise where actions, human beings, and the environment intersect. Therefore, transactional world-views allow a conceptualization of mobile learning contexts as a nexus between learners' participation in multiple settings. Such world-views on mobile learning need to conduct an intersectional analysis that embraces spatial and temporal aspects as well as processes of change. Mobile learning discussed from such an approach is a dynamic and ecological phenomenon that takes into account the inseparability of human beings from their actions and the nexus of the multiple settings in which these actions occur. Moreover, such an account of mobile learning recognizes cultural, historical, and social aspects of human actions. Both the pragmatist and the sociocultural perspectives link to such a transactional world-view.

As the quotes above from papers by some of the most prominent writers within the field of mobile learning suggest interactional world-views suit with demarcated conceptualizations; however, if a conceptualizations takes into account the contextual and situated character of mobile learning, it might benefit from the application of a transactional world-view. As discussed above, such a world-view is applied in studies of mobile learning. Nevertheless, the use of concepts in such studies should benefit from being demarcated from ideas derived from dualistic and interactional world-views. This paper emphasizes the importance of being consistent between the chosen world-view and the application of concepts in analyzes, descriptions, and discussions of mobile learning. A careful choice of concepts seems to be important to avoid interactional connotations in conceptualizations of mobile learning. Following the distinction between interactional and transactional world-views, the final section of this paper comprises suggestions on how to apply transactional world-views in conceptualizations of mobile learning.

3. CONCEPTS IN MOBILE LEARNING

This paper suggests that contextual and situated analyzes, descriptions, and discussions of mobile learning benefits from concepts that have an intersectional character. This intersectional character can afford conceptualizations of mobile learning with a coherent link between world-views and applied concepts. Embracing such concepts links mobile learning to two or more aspects of its contextual and situated character. Support for such a claim comes from a well-quoted definition of mobile learning. Sharples et al. (2007, p. 225) defines it tentatively as "the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies". An interpretation of this definition implies that mobile learning can be analyzed, described, and discussed as an intersectional phenomenon that is understandable if it simultaneously embraces aspects of mobility as well as learning. This interpretation has been documented in studies of mobile learning (e.g., Sharples et al., 2007; Traxler, 2007; Wu et al., 2012). Mobile learning can, based on this definition, be interpreted as a phenomenon that occurs at the intersection of aspects such as communication, the environment, human beings, learning, and technologies. Below are a few suggestions for how such intersections can be embraced in a conceptualization of mobile learning.

An important phenomenon of mobile learning is the intersection between the people involved in the mobile learning process. In studies of mobile learning, different concepts are applied to emphasize this process, such as communication, collaboration, conversation, dialogue, and interaction. The last concept, interaction, is frequently applied in such studies. However, it has been found that the concept of interaction is applied in conceptualizations built on both interactional and transactional world-views (Jaldemark, 2012). Moreover, interaction sometimes is discussed as a phenomenon that concerns the interplay between a human being and a non-human object, e.g., a course or technologies such as tablets or smart-phones. Other applications of this concept include the interplay between human beings. This makes the concept indistinct in transactional applications. Nevertheless, it fits better within applications of demarcated dualistic interactional world-views.

To discuss the interplay between human beings, dialogue is a concept that seems to be suitable. This concept is an intersection of communication between at least two participants. In the Bakhtinian (Bakhtin, 1935/1981) sense, dialogues define the communicative interplay between human beings, between the listener and the speaker, between the writer and the reader. This concept can include communicative actions that are independent of boundaries by space and time. Another concept related to the interplay between human beings is learning communities. The concept of communities is an old concept discussed by, among others Dewey (1916), and during recent decades, it has been popularized, in terms of learning communities, by Lave and Wenger (1991) among others. This concept is an intersection of learning and communication between human beings. Moreover this intersection also embraces its relation to cultural, historical, and social aspects of being members of different communities. It can be included in an intersection with technologies, e.g., in terms of mobile learning communities and online learning communities.

Another important phenomenon in mobile learning is the intersection between human beings and the surrounding environment. As discussed above, a transactional world-view excludes dualistic claims. Therefore, the concept of the environment needs to be carefully used to avoid dualistic interactional deployments. As transactional approaches are non-dualistic, it is recommended to avoid wordings that indicate the existence of multiple environments and different types of environments, e.g., geographical environment, learning environment, or social environment (Jaldemark, 2010). In short, there is only one environment. Moreover, in academic discussions, the concept of a learning environment is usually unclear and undefined. The difference between applied technological concepts and a so-called learning environment needs to be discussed to reach a coherent understanding. Therefore, understanding and conceptualization could benefit from the application of other concepts that are more suitable, e.g., a learning management system, technology, tools, or educational settings. Among these suggestions tools could be used as a concept to replace the learning environment as an intersection between a human being and technology. This concept emphasizes the involvement of human action. This is claimed by, among others, Vygotsky (1978) who indicated that, before being used, a technology is just an object: it needs a system of human activity in which it "could serve as a conductor of human influence" (Vygotsky, 1978, p. 55). To conceptualize the intersection of human beings with the environment, one suggestion is to apply the concept of setting. A setting is something in which a human activity exists and refers to the totality of the surrounding conditions. Settings

can embrace cultural, ecological, historical, and social aspects. Therefore a setting relates to the past, present, and future states of the surrounding conditions. Different settings, e.g., educational settings, home settings, leisure settings, and work settings, might intersect in mobile learning (e.g., Milrad et al., Forthcoming). In short, a setting is a concept that addresses human action in different contexts and situations.

Studies of mobile learning can embrace concepts that comprise intersections of two or more aspects of mobile learning. Such a conceptualization could reflect the mobile character of learning regarding the interplay between human beings and issues of time, geographical movement, and the deployment of various devices. This reflective paper has raised some issues on the conceptualization of mobile learning. Its aim has been to challenge the way in which mobile learning is conceptualized. In this challenge, ideas from pragmatist and sociocultural perspectives, in terms of a dynamic, ecological, non-dualistic transactional approach to the conceptualization of mobile learning, are identified as fruitful because they reflects the current contextual and situated debate within the field of mobile learning.

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M-LEARNING SYSTEMS DESIGN - TECHNOLOGY AND PEDAGOGY ASPECTS

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ABSTRACT

Technology developments face universities with many challenges – to integrate technologies in educational processes, design new electronic materials, change teaching styles, and better meet the demands of the technology-savvy generation. The paper considers problems of m-learning adoption in Bulgaria at one Faculty of the Technical University – Sofia.

KEYWORDS

m-learning, learning management system, courses design.

1. INTRODUCTION

Today, technology trends in informatics and telecommunications are behind a change in educational service provision – from e-learning to mobile learning (m-learning). Technologies provide users with opportunities to communicate and access information, learning content and services everywhere, at any time. Their use in the educational process enables universities to offer flexible training and a better quality, and allows access to education at anytime and anywhere. However, the design of courses and lecture modules accessible at various devices, and the preparation of educational materials provide many challenges to the rapid uptake of m-learning (Gourova et al., 2013). While students, equipped with up-to-date portable devices and skills to use them, are generally ready for m-learning, the technology environment in universities and especially the teaching staff are lagging behind. Some of the problems are linked to the lack of skills for m-learning courses design, lack of methodology, and lack of user-friendly technology environment that facilitates fast and easy access to content. All these problems are addressed by a current project at the Technical University – Sofia (TU). The project foresees the development of a knowledge management system at the English Language Faculty of Engineering (ELFE) and the integration of new forms of education such as m-learning, video lectures and virtual labs. This paper presents the main challenges identified by the ELFE team for m-learning at TU. Subsequently, the paper provides a brief description of the Learning Management System (LMS) to be developed at ELFE, and the pedagogical framework considered for preparation of the learning materials.

2. M-LEARNING CHALLENGES FOR UNIVERSITIES

Technologies have changed the way people live, work, entertain and communicate. The changes in Internet technologies from Web 1.0 to Web 2.0 and Web 3.0 (the Semantic Web) have caused the development of new business models and innovation concepts, as well as institutional and educational changes. While scholars discuss about Learning 2.0 and Learning 3.0 concepts (Rubens et al., 2011), the appearance of various portable devices and the rapid uptake of mobile communications has facilitated the emergence of m-learning. Although related to e-learning, it differs in its contexts and the devices used. As defined in (Vinu et al., 2011), m-learning '*happens when the learner is not at a fixed, predetermined location, or ... when the learner takes advantage of the learning opportunities offered by mobile technologies'*. As Naismith and Corlett (2006) stress, some critical factors are in place in m-learning projects:

1. *Access to technology*: making mobile technology available where and when needed, either by developing solutions for various devices, or by providing learners with devices they can use.

2. *Connectivity:* using wireless connectivity to provide access to learning resources, to link people across contexts, and to allow students to capture material that can be sent to a personal media space and shared.

3. *Integration:* integrating mobile learning projects into the curriculum, the student experience, or daily life. Strategies for achieving integration include extending a successful form of learning onto mobile devices and proving technology that augments the student experience.

4. *Institutional support:* for mobile format of resources, training staff, technical support.

While the first two are generally solved by technology providers, the last two create big challenges for educational institutions. On the one side, the old generation of teachers is not ready to change teaching style, courses design and collaboration channels. On the other, university technology platforms in most cases do not integrate collaborative and sophisticated searching tools, and do not offer flexible and easy navigation opportunities. Last, but not least, the overall educational environment, including regulatory framework, hierarchical structure, culture, norms, etc. does not support revolutionary changes. It should be taken into account, however, that the users of educational services are technology savvy young people that grew up with the Internet and the computers, with mobile phones and other portable devices. Present learners have other requirement then the former generations. They use intensively technologies in their everyday life, and would like to use them also in the educational environment. Obviously, a change towards m-learning is needed.

Unfortunately, m-learning systems are not very popular in Bulgaria although several pilot projects are underway (Georgieva et al., 2011; Gourova et al., 2013). The widely adopted model for e-learning in the country is based on a Moodle platform, where teachers create courses and upload educational content for students, mainly lectures, study tasks, self-study materials. The teachers are skeptical about m-learning. A serious barrier for them is the lack of training and technical expertise. Adapting educational methods to m-learning needs, redesign course materials and activities could also impose difficulties for them.

3. CONCEPT FOR LEARNING MANAGEMENT SYSTEM AT ELFE

Most Bulgarian universities have developed their own platforms with the objective to facilitate educational and administrative processes. TU has a decentralised information technology (IT) infrastructure, whereas all Faculty maintain their own resources, and use the common IT resources at TU, which include:

- *University information system (for students management)* – contains information about TU students – their learning status, notes on exams, thesis information, social insurance, etc.;
- *System for staff management* – includes information on full-time and guest teachers at TU, their work load, courses, exams' responsibilities, work reports, etc.;
- *System for records management* – focuses on generation, control and publishing of exam records;
- *System for publications* – provides information on all publications of TU researchers.

TU information systems provide different access options according to the level of security envisaged (Figure 1). All lecturers could access with a digital certificate the systems for publications, staff management and students' notes and records. The system for students' management is accessible for students only for reading after online authentication. The internal administration is managed by authorized personnel at all TU Faculties using a specially installed application on their computers. The main problem is that all systems are developed and maintained separately, and there is no integration option presently.

ELFE maintains a separate web portal with information for students and lecturers, with access to ELFE annual conference and projects. One of the problems of the portal is that it is not user-friendly, does not provide single entry to all Faculty resources, and does not offer collaboration opportunities. Therefore, within the ongoing project is developed a concept for a new web platform which envisages a single sign-up process for accessing administrative and educational resources, scientific information and research data bases (Gourova et al., 2012). Some of the essential functionalities which will be added will facilitate:

- *Learning processes management* – for courses selection, assessment, thesis management, etc.
- *Human resources management* – for career promotion, training, evaluation of lecturers' performance;
- *Knowledge and technology transfer* – access to scientific data bases, partners' search, etc.
- *Collaboration facilities* –for internal and external communication, alumni fora, social networks, etc.

The most important issue is to overcome the fragmentation of ELFE IT resources (common TU systems and own systems). While the integration of all databases is not considered at TU, the users access could be facilitated by redesigning the ELFE platform and providing single sign-in to all IT systems.

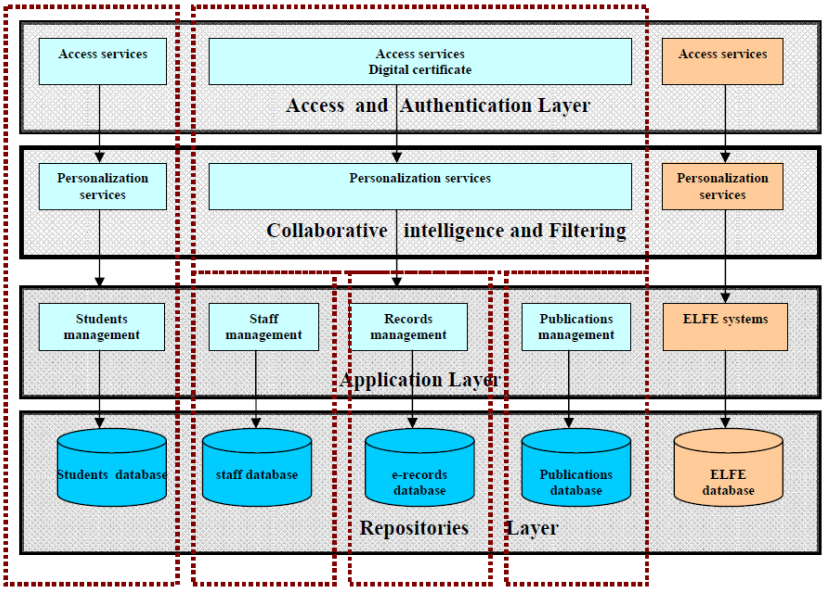

Figure 1. Available IT infrastructure at TU and ELFE

The concept for a new ELFE LMS (Figure 2) addresses the requirements for digital content presentation (to be used on both, mobile devices and desktop computers) and the opportunity for different type of content – text, audio and video. It is essential to ensure device-independent applications, modular structure of courses, extensibility and reusability of content. Additional features could be added such as reminders, tasks management, access to on-line libraries, communication tools, etc. The LMS functionalities should ensure to be easy-to-use (in terms of access, content management, presentation and navigation), intuitive and to support all users' profiles, educational needs and roles. It should also take advantage of the opportunities offered by Web 2.0 for social interaction. As distance education is presently not offered at ELFE, the LMS development will go in parallel with the design of electronic educational materials. A special Handbook is envisaged to be elaborated with guidelines to tutors, and training and expert consultations.

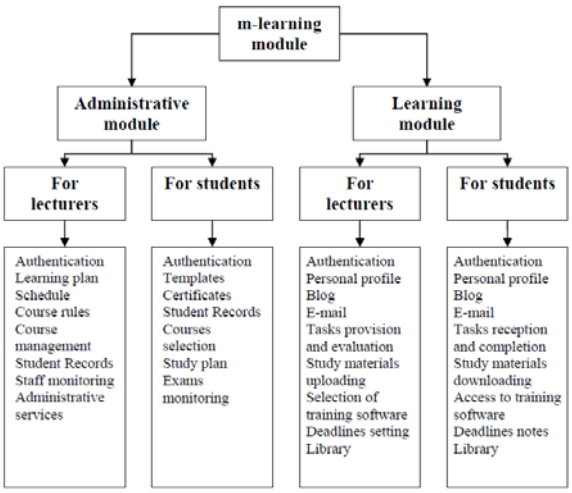

Figure 2. Concept for ELFE LMS, adapted (Ilcheva, 2013)

4. PEDAGOGY FRAMEWORK FOR M-LEARNING

M-learning faced researchers and practitioners with several questions that need to be resolved. Some challenges are linked to the development of m-learning standards as m-learning systems do not support e-learning specifications (Georgieva et al. 2011). These problems are taken into account in the ongoing TU project, which will integrate innovative forms of education such as m-learning, video lectures and virtual labs. It is considered to prepare a common design of courses and lecture modules accessible at various devices. This requires to develop as well an appropriate pedagogical framework according to different educational goals, and to determine the type of learning activities and the devices to be used for m-learning.

According to (Park, 2011), the most serious issue faced by mobile learning is the lack of a solid theoretical framework. Thus, he proposes a conceptual and pedagogical framework based on high versus low transactional distance and individualized versus socialized activity. According to his model, the following types of m-learning could be considered: (1) high transactional distance socialized m-learning, (2) high transactional distance individualized m-learning, (3) low transactional distance socialized m-learning, and (4) low transactional distance individualized m-learning. Park (2011) further points out that m-learning based on high transactional distance and the individualized mobile learning (type 2) require more psychological and communication space with the instructor or instructional support; tightly structured and well organized content and resources accessible by mobile devices; control over the learning process.

The interactions mainly occur between the individual learner and the content. This type demonstrates an extension of e-learning which allows greater flexibility and portability. Individual learners could incorporate this flexible learning into their mobile lifestyle. The pedagogical design of learning activities suitable for m-learning could be accomplished using the following steps:

- definition of learning objectives and accordingly formulation of a few basic types of activities;
- adaptation of the activities to the used learning styles;
- activity breakdown into individual actions and operations;
- technological and functional support of the activity for the appropriate mobile device.

Taking into account the success factors for m-learning given in (Naismith et al., 2011), the ability to acquire information about the user and his/her environment presents a unique ability to personalize the learning environment. This suggests studying the users' behavior in order to facilitate the navigation in the LMS and the usage of its resources. An essential component of the concept for m-learning at ELFE is to use well-structured and well-organized resources like video lecture, which should meet the following criteria (Gourova et al., 2013): clear pedagogical model for the formation of an audio-visual presentation; easy navigation within the platform; improved access to services; easy navigation within the module; brief description of the module; maintenance of high video quality; availability of options for generation of different image sizes and video quality. It is essential to follow some basic principles (Mayer at al., 2003):

- *Principle of multimedia* – improved retention by the use of words and images (double encoding);
- *Principle of spatial continuity* – better learning when words and images are placed close to each other;
- *Principle of continuous time* – simultaneous presenting corresponding words and pictures;
- *Principle of coherence* – removing superfluous words, images and sounds from multimedia content;
- *Principle of modality* – better learning through animation accompanied by voice, not by text;
- *Principle of redundancy* – presenting information in a single modality, without excessive repetition.
- *Design principle* – multimedia design influences better entry-level students than advanced learners;
- *Principle of direct manipulation* – The influence of changes in the speed of the animation or broadcast on the transfer of knowledge increases collinearly to the complexity of the material.

When creating video lectures for m-learning, it is important to notice that the design of lessons should adapt to the expertise and the prior knowledge of the learner, the complexity of the content, and the interests of the learner. Experienced researchers recognize that the use of multimedia technology and resources can vary in the level of interactivity, modality, sequencing, pacing, guidance, prompts, and alignment to student interest, all of which influence the efficiency in learning (Clark at al. 2006).

5. CONCLUSION

M-learning is not going to fully replace traditional learning approaches. However, it provides an excellent option for teamwork, interactivity, and seamless collaboration of students in a group or with their teachers. It is a new trend in education reflecting the changes in technologies but also the habits of the new generation of computer-savvy students. The functional abilities of mobile devices for text, audio, and video lectures pointed out in the paper are a motivation factor for widely using these opportunities in future m-learning systems. Several challenges for m-learning still remain – to develop m-learning standards for learning objects, to ensure device-independent and interoperable applications, etc. The development of learning management systems using Web 2.0 and Web 3.0 tools at Bulgarian universities could further facilitate users. The most essential is, however, to train teachers and motivate them to use the new educational opportunities available with the development of ICTs in order to better meet students' demands and to ensure higher quality of teaching and to better prepare the future employees for the labour market.

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THE POTENTIAL FOR MOBILE LEARNING IN ENGLISH AS A FOREIGN LANGUAGE AND NURSING EDUCATION

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ABSTRACT

This paper investigates the application of mobile technologies to support learning in a specific field: nursing education for English as a Foreign Language (EFL) learners, which is the context of the author's institution. Using a qualitative meta-synthesis methodology, factors from published literature that facilitates success in mobile learning for nursing education and EFL learners are explored. The gap between the m-learning ideals of designing of learning activities that leverage the capabilities of mobility across location, technology, conceptual space, social space and across formal or informal contexts (Sharples et al., 2009) and the published research in formal EFL language learning and nursing education are discussed.

KEYWORDS

Mobile learning, nursing education, EFL (English as a Foreign Language) education

1. INTRODUCTION

The field of mobile learning (m-learning) is a field that has "attracted a great deal of attention from researchers in different disciplines who have realized the potential to apply mobile technologies to enhance learning" (Keskin & Metcalf, 2011, p. 202). This paper will investigate the application of mobile technologies to support learning in a specific context: nursing education for English as a Foreign Language (EFL) learners. The primary research question is: What are the best practices for implementing m-learning in nursing education within an EFL context? The factors that facilitate success for mobile technology implementations in nursing education and the pedagogical implications for EFL learners in m-learning will be explored.

2. METHODOLOGY

For this paper, a qualitative meta-synthesis based on thematic analysis is used. A comprehensive literature search was done, and data collection involved finding published articles and studies in peer-reviewed journals, and dissertations. Search strategies included searching library databases recommended for both nursing and education topics, including education focused ERIC and Education Research Complete, as well as the nursing focused database CINAHL Plus. Searches were for resources matching two combined key terms. The first term was PDA, smartphone, handheld, mobile learning or m-learning. The second term was either nursing education or English as a second language (ESL), English as a foreign language (EFL), English language learning (ELL), second language instruction, or mobile assisted language learning (MALL).

The inclusion criteria were designed based on finding published primary research that used mobile technology to support the course-based learning activities of university level EFL or nursing students. Only primary research reports that included students or faculty were used. Topics needed to include pedagogical strategies for learning with mobile devices, focus on either one of second language learning for academic purposes, or nursing education; and results needed to be reports of experiences, perceptions, usefulness, barriers, affordances and/or learning outcomes of mobile technology implementations. The year 2005 was

chosen as a cut-off point by the researcher, because of the changes in hardware availability and multimedia capabilities of mobile devices is changing so rapidly. Some resources had to be excluded because full text was not available online. This resulted in a final set of articles for the synthesis, with 43 in the nursing subject area, and 23 in the language area (complete list available from author upon request).

3. RESULTS

A number of factors were discovered, that aid in successfully implementing m-learning in nursing education. In the case of mobile reference support (the highest frequency of published studies) the benefits included a perceived reduction in the likelihood of medication errors (Beard et al., 2011; Goldsworthy, Lawrence, & Goodman, 2006; Farrell & Rose, 2008), increases in levels of student confidence and self-efficacy (Bauldoff et al., 2008; Goldsworthy, Lawrence & Goodman, 2006), as well as having access to up to date information at the point-of-care (Beard et al., 2011; Brubaker, Ruthman & Walloch, 2009; Cahill & Li, 2011; Clark, Colevins, & Bond, 2009; George et al., 2010; Kenny et al., 2009; Scollin et al., 2006; Wyatt et al., 2010). Perceptions of improved information seeking behaviours and improved decision making capabilities were also listed (Bauldoff et al., 2008; Miller et al., 2005; Williams & Dittmer, 2009). Student impressions in some studies state that the handheld improved their problem solving and critical thinking skills (Fisher & Koren, 2007; Wyatt et al., 2010), their expectation to use professional judgment (Newman & Howse, 2007), and their confidence in the clinical setting (Bauldoff et al., 2008; Colevins, Bond, & Clark, 2006; Fisher & Koren, 2007; Kuiper, 2010; Tilghman, Raley, & Conway, 2006). These perceived benefits were based on a combination of qualitative and quantitative reports.

Successful implementations were also connected by six commonly mentioned factors. Modelling of technology use by instructors was found to be important for students to understand appropriate use (Altman & Brady, 2005; Cibulka & Crane-Wider, 2011; Scollin et al., 2007;; White et al., 2005; Wyatt et al., 2010),. Student orientations, although done in many different ways, need to be done in ways appropriate to the institution. Implementation teams were often multidisciplinary in nature, and involved campus departments such as IT, the library, and financial personnel as well as nursing faculty and support staff. Technical support was often needed, and an agreed upon framework for this support was not found from the literature. A relatively common group of software applications from one vendor chosen by implementation teams, and the recommendation to add titles as needed by students were seen. Costs and support structures are affected by variations between implementation models: loaner or required purchase (Altmann & Brady, 2005; Beard et al., 2011; Cibulka & Crane-Wider, 2011; Hudson & Buell, 2011; McLeod & Mays, 2008). Inclusion of mobile reference support across the curriculum is recommended by many as a way to familiarize students with use before they are to use handhelds at clinical placements (Bauldoff et al., 2008; Beard et al., 2011; George et al., 2010; Hudson & Buell, 2011; White et al., 2005). There were also a number of other listed barriers, including misplacing handhelds because of their small size, transmitting pathogens, and ensuring patient confidentiality rules are adhered to.

M-Learning has been shown to be of value for EFL students. This may be in the form of incidental vocabulary learning, where learners use mobiles to quickly look up the proper meaning of words as they encounter them (Song & Fox, 2008). Intentional vocabulary acquisition can also be assisted in a more teacher-directed fashion, when SMS messages are sent from the instructor to the learner's mobile throughout the day with directed vocabulary content (Levy & Kennedy, 2010; Thornton & Houser, 2005), or when students are given access to systems that help them practice (Zhang et al., 2011; Basoglu & Akdemir, 2010). Listening and speaking skills may be practiced through the playback and creation of podcasts (Abdous et al., 2009; Thornton & Houser, 2005), or the use of phone-in systems (Demouy & Kukulska-Hulme, 2010). M-learning modules can help students practice reading or vocabulary activities in a supported and mobile way (Chen & Hsu, 2008). Kondo et al. (2012) concluded that mobile applications could facilitate second language student's self-directed learning, albeit with teacher support. Limitations have also been noted with m-learning in language learning, and the literature cautions instructors to be cognizant of the readiness level of their students (Stockwell, 2008) and their institutions (Wishart, 2008) to accept mobile devices as learning tools.

4. DISCUSSION

The analysis has resulted in highlighting the development, successes and challenges of m-learning in two fields: second language learning, and nursing education. The expansion has been quite different among the two, and even within the fields.

In nursing clinical education, there has been a decidedly systematic implementation of handhelds to fulfil the need of providing point-of-care information to students especially while on their clinical placements. There is plenty of published and relatively cohesive research discussing programs that are highly developed, connected and threaded throughout the curriculum, with attention paid to implementation committees, orientations, support structures, device and software as well as costs to students and faculty all being considered. Faculty development is often mentioned as a key to success, and models and processes for this development are emerging. This is a unique setting, where the use of mobiles appears to be well suited to a specific niche. The use of handhelds has also moved into the nursing classroom stream, as the use of the clinical reference materials as a scaffold before entering the clinical site has been well received. Mobile devices are becoming an ingrained and established part of nursing education, at least in the clinical or clinical preparation realm.

The fields of language learning have had a somewhat different development, where the specific need is not as well defined or agreed upon as it is in nursing clinical application. In the case of language learning, m-learning is being used to support vocabulary acquisition and to provide listening and speaking practice, with success being shown in immediate post-tests and student satisfaction.

Mobile devices are becoming an engrained part of nursing education, so there is the potential to leverage positive language m-learning activities into nursing programs to support EFL students' learning. Nursing clinical education is an exemplary example of using mobiles for performance support, where information is delivered just-in-time and in context to enhance productivity (Traxler, 2010). In the area of language learning, and specifically incidental vocabulary acquisition, the use of mobile dictionaries and translator software as shown by Song & Fox (2008) is also an ideal in-context support for learners. In both fields, there is a replacement of traditional paper-based resources commonly used by learners with a mobile format. While the major benefit of this may simply be convenience of access anytime or anywhere, by modelling for learners how they can make use of mobile supports when they do not have access to paper-based resources or instructors, there is the potential to teach information-seeking behaviours to better support their learning needs. In the case of nursing, these improved information-seeking behaviours were also linked with improved self-efficacy. The field of language learning could possibly take a lesson from nursing implementations, which because of a practice common in the nursing profession have recognized the power of teaching students how to use mobile reference material to support their need for information in the location they need it. Second language learners are constantly in the process of learning new vocabulary outside of the classroom, and using formally teaching students to use mobile devices to learn vocabulary incidentally and as needed may lead to increased self-efficacy as was seen in nursing. Supporting learners and faculty to see mobiles as learning devices may be beneficial. While not all learners may adopt and use these skills, that is not reason enough to exclude the idea.

An often-cited benefit of m-learning is the increased potential for communication and collaboration, (Kearney et al., 2012; Cochrane & Bateman, 2010), although it is not often realized in education (Kukulsa-Hulme et al., 2009). This idea is supported from the synthesized literature. There are examples of teacher-to-learner communications, where the instructor pushes content out to learners and possibly the student responds. This mirrors traditional didactic, teacher-centred instruction. One stand out in this statement is the case of learner-generated podcasts, where there is an example of learner-to-learner interactions, although they are asynchronous. In nursing clinical education, even when interaction capabilities were made available to students, they were not heavily used (Kenny et al, 2009). This underuse could be because in the group of studies reviewed, the need for two-way, synchronous discussions was best served in the face-to-face classroom. The majority of the uses of mobiles involved learners interacting with content. This may mean that research in the fields up to this point are focused on projects that parallel traditional instructional techniques, or it may mean that there is not a need for communication and collaboration in these fields. Perhaps faculty have not imagined new pedagogies that leverage this part of the technology yet.

Conceivably the key to understanding m-learning is from the perspective of the student, and finding what they need to support their learning. In traditional didactic instruction, the instructor is the source of

information. In this new generation of learning, that is no longer the case. Instructors can find ways to help learners discover that their mobile devices may be supportive of their learning in a personalized way. For each learner, the set of tools may vary. The success of providing junior nurses with access to reference support in the context of patient care has been highly successful. For language learners, the environment of language learning surrounds them in their daily activities in classrooms, writing assignments, speaking and listening through their participation as students. Learning to make use of mobile phones as a tool for language learning has potential to support them wherever they encounter issues or have time for review. By no means are mobile phones replacements for instructors or books in a formal learning environment, but they do have solid potential for supporting learners.

The field of m-learning stresses that the potential in the designing of learning activities that leverage the capabilities of mobility across location, technology, conceptual space, social space and across formal or informal contexts. There is a considerable amount of difference between these ideals, and the published research in formal EFL language learning and nursing education. To close the gap, the entry point into m-learning for most faculty will be from a personal standpoint when the technology proves useful in their everyday lives, which is conceivably very difficult or unlikely in some cases. Only with a sense of personal conviction, combined with communities of support individually and institutionally, is it likely than new pedagogies will be imagined.

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PROMOTING STEM EDUCATION THROUGH MOBILE TEACHING AND LEARNING

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ABSTRACT

The recruitment and retention of more students, especially women and minority students, into science, technology, engineering and mathematics (STEM) programs is a critical need in technologically advanced countries like the U.S. as there is expected to be shortage of qualified STEM graduates in the future. Educators have to find new ways to interest and engage current generation of students in STEM programs, and the recent advancements in mobile teaching and learning offer promise in this regard. In this paper, the unique needs that STEM courses pose with respect to teaching and learning are identified, and the opportunities that mobile teaching and learning offer to meet those needs are discussed. Mobile teaching and learning is proposed as a solution for recruiting and retaining students in STEM programs and meeting the needs of technologically advanced countries such as the U.S.

1. INTRODUCTION

Stagnating student enrollment in science, technology, engineering and mathematics (STEM) degree programs has been a concern in technologically advanced nations, especially in the U.S. (Hall et al., 2011). The need for scientists and engineers is predicted to be even greater in the coming decades as the number of qualified science and engineering graduates may not be sufficient to fill industry's needs. The lack of increase in enrollment by women and underrepresented groups in STEM programs is also a concern (Burke & Mattis, 2007). As societal factors often contribute to the lack of participation of women and underrepresented groups in STEM programs, especially in the U.S. compared to developing countries, the concern warrants innovative solutions. These concerns could be addressed by exploring teaching strategies and the use of instructional technologies in STEM fields, and finding new ways to meet the needs.

Teaching strategies and technology integration in STEM classrooms continue to follow traditional approaches in the U.S. This is somewhat due to the unique needs of STEM fields and the experience and expertise of faculty teaching in those fields. However, failing to adopt more modern teaching methods and integrate current technology could be contributing to the lack of increase in enrollment and the participation of women and underrepresented groups in STEM programs. The growth in the use of mobile devices among school and college students and the recent innovations in mobile technologies provide opportunities to promote STEM education through mobile teaching and learning.

2. STEM EDUCATION NEEDS

Along with the common educational needs of any field, STEM programs place some additional demands related to course content, delivery, interaction, and assessment on faculty.

a. Delivery strategies – STEM faculty often utilize traditional approaches to teaching, including lectures, due to the need for conveying theory and background information, which students may not generally be inclined to read and learn on their own. The traditional approach to teaching in STEM fields may also be partly due to the way faculty themselves learned when they were students, and as a result, tend to use the same approaches when they teach.

b. Mastering the fundamentals – Courses in STEM fields require mastering theory and fundamentals first before moving onto advanced courses. Therefore, it is critical to engage students in the introductory courses and help them relate to the course topics so that they can be successful in their chosen STEM majors.

c. Experimentation – The ability to conduct experiments in a laboratory or practical setting is one of the critical needs of STEM fields. Such laboratory work often involves setting up and calibrating instruments, following safety procedures, conducting experiments, collecting data, and analyzing data.

d. Team work – Team work is one of the top two needed skills by employers in STEM fields, and students are expected to work in teams in STEM courses to complete course projects and assignments (National Association of Colleges and Employers, 2012).

e. Communication – Communication is the other top needed skill mentioned by employers and communication in STEM fields includes writing and presenting technical information. Students are also expected to work in teams to write and present project reports.

f. Research – In STEM courses, students are expected to explore past work on a particular problem before proposing new or better solutions, research information on equipment and materials necessary for conducting laboratory experiments, and look up standards and data sheets for solving problems.

g. Symbols, drawing and visualization – Students as well as faculty in STEM courses need the tools to type or write mathematical and scientific notations, draw charts and diagrams, and visualize images in multiple dimensions. This ability is needed for developing and delivering content as well as for interactions between faculty and students and among students.

h. Testing and assessment – Assessing student learning in STEM fields requires more than multiple choice or fill-in the blank tests. Such tests may be necessary to demonstrate comprehension of background information but are not sufficient to demonstrate problem-solving skills. It is more important to be able to assess students' ability to conceptualize and solve problems. In some cases, demonstrating the problem-solving process is more critical than reaching the final answer.

The above mentioned teaching and learning needs of STEM disciplines must be addressed in order to make any meaningful impact on student recruitment and retention, and to introduce any new pedagogical techniques or instructional technologies.

3. MOBILE TEACHING AND LEARNING IN STEM PROGRAMS

Mobile teaching and learning provide unique opportunities for addressing many of the STEM education needs (Roshan, 2011). Corporations are also recognizing these opportunities (Verizon, 2012). As mobile devices become prevalent and affordable, more educational innovations are being introduced. Devices for mobile learning are not limited to smart phones but also include personal response systems (clickers), tablets, e-readers, and more.

Mastering the fundamentals is a challenge in STEM fields. Some students find the introductory courses boring and do not recognize their relevance to learning advanced topics. As a result, these students may become discouraged and disconnected. Some may drop out or change majors. What is needed is a way to reach students, make content more engaging, and motivate them to spend time on learning. Mobile technologies are a potential solution. By extending online technologies, students can access course materials easily through their mobile devices. Numerous online tutorials are available for learning foundational concepts in STEM fields. By making sure that those tutorials are mobile-compatible, students can be encouraged to access such educational materials through their mobile devices. More so than desktop workstations, mobile devices can infuse game mechanics into learning which can be more motivating. In addition, students can collaborate with one another using mobile devices.

Delivering content through mobile technologies can be accomplished in many ways that engage students and increase learning. For example, faculty can deliver lectures using synchronous methods using learning management systems such as Blackboard Collaborate™, and students can participate on their mobile devices. Faculty can also embed videos and problem solving steps in their mobile lectures. Figure 1 shows a sample of a mobile lecture through Blackboard Collaborate. Lectures can also be recorded and delivered asynchronously, which allows students to watch them repeatedly, until they feel comfortable with the content. This is an obvious advantage over face-to-face STEM classrooms. In some developing countries, course lectures are even delivered as audio files through smart phones on a weekly-basis.

There are many opportunities to use mobile technologies to enhance or replace STEM experiments and laboratory work. While not all experiments and laboratory work could be accomplished through mobile technologies, some could be conducted with smartphones or tablets. There are portable lab kits available for some disciplines to conduct all the laboratory experiments at students' homes (Jaanus et al., 2007). Some universities have also designed experiments that students can conduct by interfacing with the experimental setup online or through mobile devices. For example, see: http://www.vlab.co.in/. The possibility of conducting laboratory experiments through mobile technologies diminishes the need for students to be present in a particular location to complete laboratory exercises. This can make STEM courses accessible to more students.

Many of today's students prefer texting and chatting compared to email or asynchronous discussion boards. Therefore, mobile technologies are ideal for communication and teamwork. Students can interact with each other using text, chat, and video conferencing through Skype™ and other similar apps. They can also record and share their individual work with each other, post their work on a course site, or collaborate on course wikis through their mobile devices.

In STEM courses, students need to be able to search for information on equipment and materials, look up safety data sheets, and search library databases for past work on a particular topic. All of these tasks can be accomplished through mobile technologies. Many STEM publishers, such as EBSCO (http://www.ebscohost.com/academic/mobile-access), have made their journal databases mobile-friendly. The voice-command features available on some smartphones make it easy for students to look up information while working on experiments.

Typing mathematical symbols and scientific notations is time consuming on a desktop computer. However, there are numerous mobile apps that make the process easier. There are also apps for drawing charts, graphs, and diagrams. Other apps, like ShowMe™ (see Figure 2), allow users to handwrite content while simultaneously recording narration. These tutorials can be shared with students for multimedia lectures. The photo and video capabilities of mobile devices also offers unique opportunities for visualization, augmented reality, and constructing new knowledge

Figure 1. Screen capture of Blackboard Collaborate™ mobile lecture

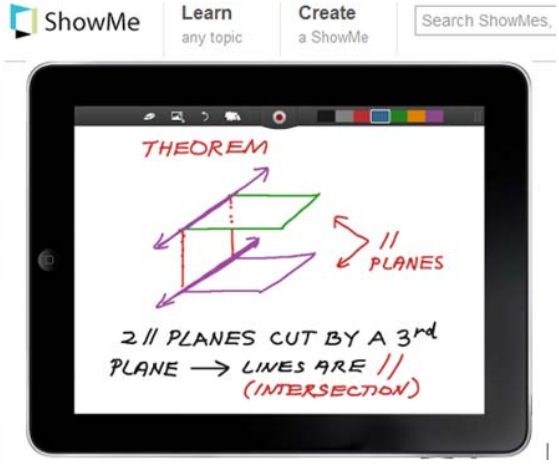

Figure 2. Screen capture of a ShowMe™ mobile app lecture

It is already challenging to test problem-solving skills in STEM courses because of the need to have students demonstrate the problem-solving process rather than just state the final answer. Students can respond to online tests and quizzes with multiple choice questions or brief answers. However, on a tablet or smartphone, students can demonstrate the problem-solving process by handwriting step-by-step answers with scientific notations, mathematical symbols, charts, and graphs, and then submit electronically. Another advantage of using mobile technologies for testing is that students can record audio explanations of their problem-solving process and submit them with the solutions..

Mobile technologies also bring additional advantages to STEM education with respect to diversity and students with disabilities. Women and underrepresented students are often in the minority in mathematics, technology and engineering courses, especially in the U.S. As a result, many are hesitant to speak in class or

interact with their professors. Students with disabilities may also feel marginalized and are reluctant to engage in face-to-face classrooms. However, the same students may feel empowered to communicate freely using mobile technologies as their identities are masked by the communication technologies.

Finally, the key to successfully implementing mobile teaching and learning in STEM courses is faculty members' willingness to explore new ways of teaching and learning. They must experiment with technology and methods to transform their courses in incremental steps. This requires that academic institutions promote mobile teaching and learning by training faculty and establishing the necessary infrastructure (Krishnamurthi & Richter, 2012).

4. CONCLUSIONS

Mobile teaching and learning offers new possibilities for enhancing STEM education, retaining students, and recruiting students from underrepresented groups, especially in the U.S. There are numerous inexpensive or even free mobile teaching and learning resources available that can make teaching and learning science, mathematics, technology and engineering courses more interesting and engaging than traditional face-to-face approaches. Mobile technologies may empower women and students from other underrepresented groups to interact more and engage in STEM courses.

Faculty should rethink their traditional approach to teaching STEM courses and explore more online and mobile technologies to meet the learning needs of the current generation of students. Faculty can experiment with adding mobile learning components incrementally to their STEM courses. As faculty feel comfortable to explore mobile teaching and learning techniques in their courses, students' attitude towards STEM fields may also change. As a result, more students may choose or continue with STEM majors, which will help meet society's needs for qualified STEM graduates in the future.

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Posters

A LEARNING COMMUNITY EXPLORES THE POTENTIAL OF MOBILE APPS IN HIGHER EDUCATION

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ABSTRACT

Faculty and staff are curious about the potential of applications for mobile devices and how they can be used to enhance learning, teaching, and productivity. However, the number of applications seems overwhelming and faculty and staff have limited time and money to consider possibilities. This poster outlines the results of a learning community formed to collaboratively learn more about possibilities and select their favorites to recommend to peers.

KEYWORDS

Mobile apps, teaching, learning, higher education.

1. INTRODUCTION

Faculty and staff at our university recognized the value of mobile devices for personal productivity and entertainment but wondered what resources were available to support academic endeavors like research, student services support, teaching, and learning. However, an investigation of the many applications available seemed overwhelming as an individual endeavor, especially with limited budgets.

We formed a learning community of faculty and staff to explore apps independently and come together to show and tell results. .

2. METHODOLOGY AND RESULTS

Faculty and staff were invited to join a learning community and participate in investigations of mobile applications that they found most useful or interesting.

All participants were offered a $25 iTunes card to use with their own mobile device in exchange for sharing their findings with the group.

The first meeting was late in the Fall semester. iTunes cards were distributed after introductions and a description of the project.

Four follow-up meetings were scheduled after the semester break. Two or three participants volunteered to present their findings at each of the next four meetings.

To encourage participants in this "divide-and-conquer" approach to exploring the repository of applications, a friendly competition was begun to see who could find the best applications in four categories:

1. best free app
2. best app to support an academic discipline
3. best app to support the profession of teaching
4. best productivity app

Six weeks after the initial meeting, the group convened again to share the findings of the first pair of participants. The next three meetings were scheduled two weeks apart, with presenters sharing their findings informally. In each of the one-hour meetings, presenters answered questions and connected their mobile devices to a projector so presenters could illustrate some of the key features of the apps they discovered.

Over 100 applications and concepts were presented. Some concepts presented were methods for projecting the iPad display, stylus options, etc. All discoveries were sorted into four categories. Participants were surveyed to select their top three choices in each category. Top selections appear in Table 1 below:

Table 1. Top Selections of Mobile Applications by Category

Free	Supporting an Academic Discipline	Supporting Teaching	Productivity
TED Talks	Wolfram Alpha	Eyejot	Dropbox
Educreations	NASA Virtualization Explorer	Keynote	Evernote
Facetime	Stats of the Union	PDFNotes	FlightTrack
EasyBib	iTunesU Darwin Open Course	ReplayNote	NoteShelf
Google Maps	Congressional Record	SyncPad	WritePad

The participant that introduced the top selection in each category was awarded another $25 iTunes card.

3. CONCLUSION

Participants appreciated the collegial atmosphere of the learning community and the diversity of the apps and other ideas that were identified. The consensus was that they would like to see regular continued meetings of an informal users group on campus to expand on the possibilities of integrating mobile applications to enhance learning, teaching, and productivity. The list of favorites was presented to peers at a campus-wide Institute for professional development.

ACKNOWLEDGEMENT

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MOBILE LEARNING APPLICATION BASED ON RSS FEED TECHNOLOGY

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ABSTRACT

This paper presents a mobile learning application for a learning course at higher education level. Based on the RSS feed technology, the presented mobile application establishes an in-time communication channel between the instructor and his/her students to keep them up-to-date with all course important dates, instructions and information in addition to a download center to provide them a permanent and fast access to all course lectures and resources. Security issues are also taken into consideration, only students who are currently enrolled in the learning course are allowed to access the mobile application through a security control which is simple and adequate in the same time. The presented mobile learning application is currently available to be downloaded and installed through Google Play store (formerly called Android Market) on almost all Android devices starting from Android 2.1 and higher. Future work includes further enrichment of the application by adding additional modules and functionalities as well as increasing the application availability by developing other versions for Windows 8 and iOS smartphones and tablets in order reach a wider range of students.

KEYWORDS

Mobile learning, RSS feed, higher education.

1. INTRODUCTION

Another important factor arises recently i.e. the wide spreading of intelligent devices as well as high-functionally operating systems such as Android for smart devices introduced by Google in addition to Windows 8 introduced recently by Microsoft. The great advantage of these new operation systems that they are compatible with large variety of mobile device regardless their manufacturers. These emerging operating systems can operate a wide range of smartphones, tablets, and even TV boxes for a huge list of manufacturers around the world. This advantage provides the application developer a high degree of flexibility in addition to the possibility to develop a mobile application that is valid for many users without caring about the brand of their devices.

Thus, new possibilities are offered to teachers to reach their students. A pilot project was proposed as first mobile learning (will be referred to it as m-learning in the rest of this document) experience in our university. The main objective of this project is to verify the feasibility of applying m-learning at higher education levels, in order to offer mobile application as a teaching alternative. This paper presents the mobile application developed and how it may be more useful than a course portal website. Such an experiment could help designers in future developments of m-learning applications.

In the rest of this paper, we demonstrate the primary suggestions of application design and how it was modified and adapted to reach a rather final design. In addition, we discuss the RSS feed technology, its advantages, and how it is employed in our mobile application. Afterwards, we show how the mobile application is implemented and deployed as well as how security concerns are treated. Next, we explain how the mobile application advantages compared with the course portal website in addition the advantages provided by the employment of RSS feed technology. Finally, we present a brief discussion about technical and administration difficulties which impede the larger expansion of m-learning solutions.

2. MOBILE APPLICATION DESIGN

In our m-learning application, we decided to develop a pilot version to run the Android environment for simplicity and the easiness to establish a proper development and simulation environment as well as the high degree of compatibility provided by the Android operating system which allows us to reach as many students as possible. The presented mobile application is compatible with Android 2.1 up to higher Android versions. This makes it suitable for a wide variety of mobile devices whether smartphones or tablets.

2.1 Primary Application Design

In order to realize as much as possible of m-learning objectives and to profit from its advantages, four modules of the mobile application were suggested:

- **Course actualities:** In order to realize the *anywhere* and *anytime* characteristics of m-learning, the objective of this first module is to establish an immediate communication channel between the professor and his/her students. Through this module, students are be up-to-date with important dates such as dates and hours of examinations, assignments due dates, a lecture cancelation, or any important information which the instructor desires to diffuse it rapidly.
- **Course lectures:** This module presents the course lectures. All course lectures are recorded and made available to be downloaded through this module. The course which our application is developed for is an in-class course and NOT a distance course. Consequently, there is no live distance lectures. Recorded video prepared by the instructor here are optional and can be considered as an additional advantage for mobile application users.
- **Download center:** The download center is the course repository where the mobile application user can find the course documents such as the course syllabus, important guides and documentations in the form of PDF (Portable Document Format) files.
- **Auto-evaluation:** This module allows the student to self-evaluate his/her progress in the learning course in the form of questions and answers and the program gives the result in the end of the auto-evaluation test in order to provides the application user the chance to identify his weaknesses points before real tests.

Upon the course instructor request, second and the third modules are merged (course lectures and download center) into one module, and the auto-evaluation module is deferred to upcoming versions.

To achieve our mobile application: we followed the RSS feed technology employed in the news websites. We need first to briefly explain this technology and its advantages.

2.2 RSS News Feed Technology

RSS (Rich Site Summary) or (Really Simple Syndication) is a web feed format developed by Netscape in 1999 in order to publish frequently updated works web contents such as news headlines and blog entries. Nowadays, this technology is widely used by news and business websites to keep their visitors updated with any changes in the website contents. The main benefit of RSS web feeds is that they summarize the latest content of a web page or a collection of web pages from different sources and allow the user to quickly link back to the original full article is he/she needs to get more details about a topic of interest.

An RSS document is a standardized XML file format. It is called a ‘feed’ or ‘web feed’. A typical RSS feed usually includes a linked headline and a short descriptive text in addition to some publishing information such as the author name and the publishing date.

The user needs an RSS reader is needed to allow him/her read RSS feeds in a human readable format. Once the reader is installed on the user’s machine (PC, laptop, tablet, smartphone...etc) and set up with RSS feeds, the RSS feed reader is updated automatically with the latest content for the feeds which the user is subscribed in.

2.3 Final Application Design

In order to realize the two agreed application modules (figure 1.a), we have employed the RSS news feed technology. Two XML files (one file for each module) are used as the feed sources as follows:

• The first xml file contains the important dates of the course and any information the course instructors desires to distribute to students.

• The second file contains links to allow application users to download PDF, audio, and video files as well as a short description for each.

An RSS reader is developed and embedded in the mobile application to parse them. Figure 1.b shows the download center module as viewed on an Android tablet.

Figure 1. a. Mobile application main page (smartphone view), b. Download center module (tablet view)

3. APPLICATION IMPLEMENTATION AND DEPLOYMENT

A secured web space is allocated on the university web server for storing the two XML files representing the sources of the two application modules. Only authorized application administrators can access this web space in campus or remotely through a secured VPN connection.

Ensuring that only authorised user who can only access the course resources is also taken in consideration. For this purpose, an encrypted access code is created randomly and stored in a secure file on the application server. At the beginning of each trimester, the course instructor distributes the current operational access code to currently enrolled student to permit them to access the mobile application. This access code is changed on regular bases e.g. at least at the start of each semester to prevent ancient students from having access to course resources. Figure 2.a shows the access code entry page which permits the user through the application if he enters the access code correctly.

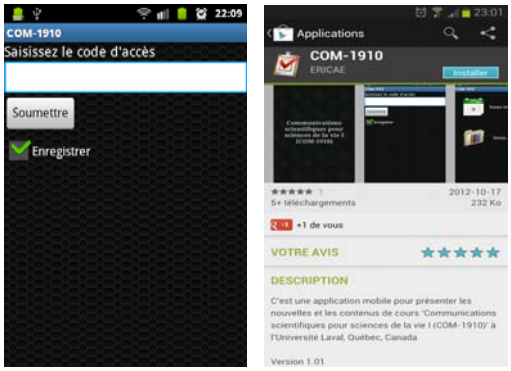

Figure 2. a. Access code screen (smartphone view), b. Application download page on Google Play store

The m-learning application is developed and deployed to Google Play store through the 'eclipse' development tool. A test version (version 1.0) is uploaded to the market. Afterwards, a final version (version 1.01) is deployed and published after adding the access code check page. Currently, the mobile application users can download and install it from the Google Play store as shown in figure 2.b.

4. ADVANTAGES OF USING MOBILE LEARNING APLLICATION

Usage of mobile telecommunication data networks is so sensitive because of their rather high costs compared with those of using office or home networks for internet surfing. Thus, volume of download data required to get certain information still a worrying obsession for most mobile data users.

Mobile applications provide a time and money saving solution for this problem. In our case study i.e. the m-learning application, the application furnishes the course enrolled students a simple, fast, and exceptionally low data bandwidth consuming tool to have access to course resources. The m-learning application provides three main advantages which can be summarized as follows:

- **Save time and effort:** less number of steps is required to access the same information of the course portal website.
- **Incredible Decrease of data bandwidth consumption:** Data bandwidth consumed in order to start the mobile application, to verify the access code, and to read the two XML files representing the two application modules is 8.99 KB. While the data bandwidth consumed to enter the login information and load home page of the course portal website is 3.81 MB which is 434 times greater than data bandwidth consumed by the m-learning application to arrive at the same point.
- **Interactivity:** Mobile applications, in general, provide high degree of interactivity with end-users. This feature is essential at the need for adding further modules such as auto-evaluation, context-aware assignments, and live surveys.

Furthermore, usage of RSS feed technology offers three key advantages:

- **Simplicity and symmetry:** Application modules are so simple and have exactly the same structure.
- **Lightness:** Pages are light to be downloaded and the application size is minimum (576 KB) which leads to considerable savings in device and telecommunication resources.
- **Maintainability:** As a result of the standard structure of XML files used as RSS sources.

5. DISCUSSION AND FUTURE WORK

The m-learning application is developed for the purpose to provide an m-learning service at the university level based on the RSS feed technology.However, the application is still an optional and supportive part of the learning course which it is applied for; thereby enrolled students in this course are not obligated to utilize it. Indeed, there are three main reasons forcing this choice as follows:

1. In the case of imposing the mobile application and making it a mandatory part of the learning course, the university -is obligated to provide course enrolled students with mobile devices required to have access to the mobile application.

2. Presently, the m-learning application is developed and ready for use on Android devices only. Consequently, students holding devices working by different operating systems will not be able use the application.

3. The third reason is an administrative one; it is a global obstacle fronting the wide spreading of m-learning, which is the fact that there is still no formal procedure agreed by the university (and many other learning institutions) to manage learning courses based entirely on m-learning technology.

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MOBILE LEARNING USING MOBILE PHONES

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ABSTRACT

The participation in mobile learning programs is conditioned by having/using mobile communication technology. Those who do not have or use such technology cannot participate in mobile learning programs. This study evaluates who are the most likely participants of mobile learning programs by examining the demographic profile and mobile phone usage patterns of those who use their mobile phones to access the internet. The results reveal that using the mobile phone to access the internet is more likely among young people and males. These users are also more likely to explore more functions of the mobile phone such as the camera, the calculator or the agenda than those who do not use the mobile phone for internet-access.

KEYWORDS

Mobile learning participation, internet-capable mobile phones.

1. INTRODUCTION

In recent years there is a growing tendency to own smartphones or internet-capable mobile phones. The expectation is for this tendency to maintain as in 2011 the selling of smartphones surpassed the selling of basic-feature mobile phones (IDC 2011). The penetration rate of this type of devices is however much different across countries. In Europe, Sweden and Spain have the highest rates (35%); at an international level Singapore is the top country in terms of smartphones penetration rate (54%) (Go-gulf 2012). Additionally, it is difficult to find consistent information regarding penetration rates of smartphones. In the case of Portugal, according to TNS report the penetration rate of smartphones is 9% (TNS 2012); the Marktest' telecommunication Barometer reports a penetration rate of 4.2% (Marktest 2012) and cross-countries investigations report a penetration rate above 30% (Sterling 2011).

The participation on mobile learning programs is restricted to people that possess and/or knows how to use internet-capable mobile devices such as mobile phones, PDA's or laptops. According to a recent report from the mobile manufacturer Ericsson (2012), by 2015, 80% of internet accesses will be made using mobile phones. Although this is good news for those developing and implementing mobile learning programs it is not synonymous of full coverage of the population regarding participation in m-learning programs. In the particular case of Portugal, despite having internet-capable mobile phones not all users use the mobile phone to access the internet. According to TNS (2012), 40% of mobile phone users with internet-capable devices do not use the internet access function, probably for cost reasons.

This study evaluates who are the most likely participants of mobile learning programs by examining the demographic profile and mobile phone usage patterns of those who use their mobile phones to access the internet.

2. DATA AND METHODS

Data comes from a mobile phone survey conducted by Marktest in 2012. The survey covered the general Portuguese population of mobile phones users aged 15 years or older. The questionnaire included questions regarding the use of mobile phones. The sample of numbers to contact was selected using a random digit dialing procedure. A total of 1,500 completed interviews was accomplished.

The analysis starts with a comparison between individuals who use their mobile phone to access the internet and individuals who do not in terms of demographic characteristics. A binary logistic regression model is subsequently estimated to identify the characteristics that strongly differentiate the two groups. The dependent variable is the "internet access on the mobile phone" coded as 1-yes and 0-no. The independent variables are sex, age, education level, professional situation, marital status and social class.

In a second step the analysis compares the two groups of mobile phone users in terms of mobile phone usage patterns.

3. RESULTS

Table 1 presents the rate of internet-access on the mobile phone by subgroups of the population in terms of sex, age, educational level, professional status, marital status and social class. For each demographic characteristic only the subgroup with the highest rate is presented.

Table 1. Rate of internet-access on the mobile phone by subgroups

Characteristic: subgroup	Rate
Sex: male	23.9%
Age: 15-24 years	35.0%
Education level: university	30.1%
Professional status: employed by a third party	23.7%
Marital status: single	30.4%
Social class: A (upper)	37.3%
Overall sample	19.0%

The overall access rate is 19%, with strong differences across subgroups. The highest percentage of internet access is found in the upper social class – 37.3% - and in the younger's group (aged 15-24 years) – 35%.

A binary logistic regression model was then estimated to identify which demographic characteristics most distinguish those who use their mobile phones to access the internet and those who do not. A preliminary analysis allowed multicollinearity to be detected among some independent variables thus excluding some variables from entering the analysis. As a consequence the model was estimated solely with age and sex as predictors. Both main effects and interaction effects were tested.

Table 2 presents the estimates of the model. Both age and sex have a significant effect ($p<0.001$). The interaction effect was not statistically significant ($p>0.1$). Specifically, the likelihood of using the mobile phone to access the internet increases as age decreases. In odds metrics for every internet-access mobile phone user aged 65 or older (the reference category) there are 16 internet-access mobile phone users in the 15-24 years group (odds=16.8:1). Additionally, using the mobile phone to access the internet is more likely among males than females (odds=1.882:1).

Table 2. Binary logistic regression estimates of using the mobile phone to access the internet

Characteristic	β	Odds ratio
Sex (ref: female)		
Male	+0.632***	1.882
Age (ref: 65 +)		
15-24	+2.821***	16.800
25-34	+2.530***	12.556
35-44	+2.117***	8.304
45-54	+1.366*	3.921
55-64	+1.061*	2.890
Constant	*–3.793***	

*p<0.05, ***p<0.001.

Subsequently a comparison between internet-access mobile phones users and other users was made regarding the use of 12 functions of the mobile phone. The outcomes reveal statistically significant differences in 11 out the 12 comparisons made (Table 3).

Table 3. Functions of the mobile phone used by type of mobile phone use (%)

Functions of the mobile phone used	Internet-access	No internet access	Difference
Make personal calls	96.8	94.6	+2.2
Make professional calls	56.1	36.7	+19.4***
Receive professional calls	58.9	39.3	+19.6***
Send SMS	92.3	62.8	+29.5***
Use the alarm clock	81.8	50.8	+31.0***
Listen to music	51.9	16.5	+35.4***
Take photos	84.9	41.4	+43.5***
Listen to the radio	30.2	13.7	+16.5***
Use the calculator	76.5	38.2	+38.3***
Play games	44.6	11.4	+33.2***
Consult/edit agenda	66.7	29.6	+37.1***
Send MMS	50.5	15.2	+35.3***

***p<0.001.

With the exception of "make personal calls" internet-access mobile phones users have higher percentages of facilities' usage than no-internet-access mobile phone users. The strongest differences can be described as follows: among the internet-access group there are 84.9% users who use the mobile phone to take photos (vs. 41.4% among no-internet-access mobile phone users), 76.5% use the mobile phone as a calculator (vs. 38.2%) and 66.7% use the mobile phone to consult/edit the agenda (vs. 29.6%).

4. CONCLUSION

Accessing the internet on the mobile phone is something that will increase in the future as the ownership of internet-capable mobile phones increases. However, for now only a small percentage of the Portuguese population – near 20% - uses their mobile phones to access the internet; moreover, there are strong differences across subgroups. But even in the "best rate" groups – upper social class and younger – the rate does not reach 40%.

The idea that mobile learning is for everyone is therefore a reality not yet upon us. Not only the coverage rate of mobile phone internet access must increase, globally and at subgroups level, but also the ability to use the mobile devices, which tend to be, in technologic terms, increasingly complex, must improve.

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SUITABILITY OF M-LEARNING TO ENHANCE LEARNING ENGLISH LANGUAGE

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ABSTRACT

Mobile learning (m-Learning) is one of the major developing areas of research in the field of education. Increased power and reduced cost of computers, laptops as well as mobile devices have paved way to new ways of learning such as e-Learning and m-Learning.This paper presents findings of the first phase of a project which intends to seek the effectiveness of m-Learning among undergraduates to study English language.The objective of this phase is to find existing practices and preferences among the target group of users. In order to elicit the information, a survey was carried out among the students of the University of Colombo School of Computing (UCSC). The analysis of the survey results reveal that most of the students are having positive attitude towards m-Learning and believe that mobile phones could be used to enhance English proficiency. Furthermore, their preferences on learning styles, as well as suggestions which will guide the research are revealed.

KEYWORDS

Mobile Learning, Questionnaire survey, English Language Learning and University of Colombo School of Computing.

1. INTRODUCTION

The use of mobile phones have transformed the way of carrying on activities by allowing easy interconnections and enhanced communications.Mobile devices network availability and penetration is happening at a dramatic pace in developing countries (Gounder, 2011). What has attracted interest in the use of mobile phones as learning devices is their potential to support anywhere, anytime access (Burston, 2011). Aamri and Sulaiman (2011) have studied the current use and practices of mobile phones in the process of learning English Language by the students of Sultan Qaboos University. The author has identified the existing uses and practices, through a questionnaire and states that the students use mobile phone in learning, but in a very limited way (Aamri & Suleiman, 2011). The above study has been useful in designing mobile learning content and therefore, the aim of this study is also to find the existing uses and practices of using mobile technology by the university students of Sri Lanka to learn English.The findings of this study will enable the researcher to better understand the context as well as to seek design considerations when developing m-Learning content.

2. THE STUDY

2.1 Methodology

The methodology used for this study was an on-line survey which was shared among all UCSC undergraduates. The survey consisted of open ended as well as closed questions.Students who participated in this survey were from two different disciplines, which were ‘Computer Science’ (CS) and ‘Information and Communication Technology’ (ICT) accordingly. The questionnaire was distributed among 800 students of UCSC and out of them, 189 responses were received within 3 weeks period with a response rate of 23.75 %.

2.2 Findings

2.2.1 Part One: General Information

Total number of respondents where 189 and out of the whole respondents, only 1 person did not own a mobile phone. The next question was asked in order to identify the widely available types of phones among the university community. Around 51% of the students owned a phone which has standard java enabled features, and 13% of students were having a smart phone, while rest of them owned a phone with basic features with voice calls and SMS.

2.2.2 Part Two: Mobile Usage

When asked about the mostly used features in the mobile phone, it was figured out that voice calls and SMS had significant usage when comparing to Camera, Music, Games and MMS. Voice calls and SMS were used by more than 50% of students and camera features were used by around 19% of students. Further, when asking about the Internet access through the mobile, it was revealed that only around 28% of students were frequently using the internet via mobile.

2.2.3 Part Three: Learning Habits

Students were asked to rank the given options with regard to their learning preferences. The given options were, Text, Listening to Instructions, Watching video, Role play/ Drama, Games, Interacting with Friends, Questions and Answers. 29% of students placed text as their first preference. Listening and learning through video tutorials have got the second and third preferences accordingly. The question related to the difficulties in learning English revealed that most of the students were having problems with vocabulary and oral skills. Students also stated that Sinhala is very useful to understand things when comparing to English.When asking about the learning aspects to be enhanced in future, more than 80% of students have stated that speaking is the most essential skill. Listening, Writing and Reading have rated as 2nd, 3rd and 4th accordingly. Few questions were asked in order to find their performance in English related examinations conducted by SriLankan government. Although 99% of respondents have passed English at the ordinary level exams, only 89% have managed to pass English in Advanced Level exams.

2.2.4 Part Four: Attitudes towards Mobile Learning

Table 1. Attitude towards m-Learning

	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
I believe mobile phones could be used to teach / learn English	18	51	26	4	1
I am willing to purchase a mobile phone with advance features if it will help improve my learning	17	48	20	12	3
I would like to install a learning application in my mobile phone to improve English proficiency	32	45	18	4	1
I do not mind paying for internet connection for my mobile, if I can learn through my mobile	10	32	32	25	1
SMS based learning application would be ideal to promote English language learning	10	36	27	25	2
Learning through mobile devices will help me to utilize my time productively	27	47	19	6	1
I think I can improve my English speaking skills through a mobile	10	50	29	10	1
I believe m-Learning will not provide any advantage for me	1	5	19	60	15
I think learning through mobile phone will not build teamwork and collaboration	7	25	32	30	6
I believe learning through mobile will increase the cost of learning	3	35	35	24	3

This five point likert scale question was issued in order to identify the attitude if the students in m-learning (Table3). By analyzing these answers, it was clear that most of the respondents are having positive attitude towards m-Learning.

3. DISCUSSION

The findings reveal that this study could be a starting point to implement m-Learning at UCSC. The survey depicts a high mobile ownership and increased usage in standard java enabled phones with voice calls, SMS, MMS and GPRS facilities. Even though the survey shows a tendency towards standard mobile phones, it is not a doubt that the society is moving from standard mobile phones to 'smart' phones (Chansanchai, 2011). Further, it is also identified that students mostly use their mobile phones as a tool to make phone calls and send SMS. Since majority of the students are rarely using the internet through their mobile, it would be a challenge to implement a solution with the aid of internet access through the mobile. However as stated in section 2.2.4 the students are willing to access internet through mobile for learning purpose. Hence we can consider a potential for developing mobile internet based solutions. Based on section 2.2.3, it would be worthwhile to investigate using mobile based solutions which target oral and vocabulary related aspects. Including the mother tongue also will be useful since the mother tongue plays a great role which should be paid attention (Atkinson, 1987). In summary, the positive attitude towards m-Learning, high usage of mobile phones, willingness to spend to access educational material, enables the researchers to conclude there is potential to use m-learning to enhance English Language proficiency among the students of UCSC.

4. LIMITATIONS AND FUTURE WORKS

The survey results which have been presented here with regard to mobile usage and practices among students of UCSC, have presented certain scenarios which can be worth investigating. According to the results, it is found that SMS can be used as a medium to learn English. Further, it encourages the researchers to provide a mechanism to enhance voice learning and vocabulary aspects through mobile devices. But, the lower response rate will limit the outcome of this study being applied for a larger society.

5. CONCLUSION

This paper attempts to identify the learner preference for mobile language learning and the attitude towards m-Learning at UCSC. The survey analysis of the results depicted that most of the students are having positive attitude towards m-Learning and believe that mobile phones could be used to enhance English proficiency. Further, this study has proved the strong potential for using SMS as a medium of English language learning. By analyzing the survey results, it is worthwhile to investigate more in implementing a solution to cater the shortcoming in vocabulary and oral skills.

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Doctoral Consortia

INTEGRATED AUTHORING TOOL FOR MOBILE AUGMENTED REALITY-BASED E-LEARNING APPLICATIONS

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ABSTRACT

Learning management systems are increasingly being used to complement classroom teaching and learning and in some instances even replace traditional classroom settings with online educational tools. Mobile augmented reality is an innovative trend in e-learning that is creating new opportunities for teaching and learning. This article proposes a research approach to integrate an augmented reality authoring tool, which enables teachers to design and deliver augmented reality learning activities on mobile devices, into current learning management systems. In this research, we aim at complementing current e-learning systems, providing a wider and richer range of learning activities for teachers and students.

KEYWORDS

Learning Management System, Augmented Reality in education, e-Learning, ubiquitous learning, Mobile Learning (m-Learning), contextual learning.

1. INTRODUCTION

Due to rapid technological advancements over the past half century, technology has become an integral part of learning environments. This has greatly changed the practice of learning (Paramythis, A., 2003). Learning management systems (LMSs) have evolved in an attempt to keep pace with the World Wide Web (WWW), incorporating new technologies as well as adding pedagogical principles to a wide variety of software tools (Álvarez García, V.M., 2011). At present, LMSs such as Moodle and Blackboard, are very successful in e-education (Farman Ali, K., 2010).

Traditional e-learning platforms, or LMSs, provide holistic environments for delivering and managing educational experiences (Dagger et. al., 2007). They present suites of tools that support online management courses and student enrollment and management, education administration, and student performance reporting. Furthermore, increasingly, these Internet-based learning systems are being used to host new tools, such as Wikis and forums (among others), which support and extend the collaborative aspects of the teaching-learning process.

Virtual environments (VEs) such as LMSs can be seen as “empty” settings which are developed for teachers to create and manage their courses and fill them with digital content (Graf, S., 2007). Augmented Reality (AR) is a variation of VEs (Azuma, R.T., 1997) that integrates virtual information with the user’s physical environment. The combination of AR technology with educational contents creates a new type of automated applications and acts to enhance the effectiveness and attractiveness of teaching and learning for students in real life scenarios (Kesim, M. et al., 2012).

VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world around him. In contrast, AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it (Azuma, R.T., 1997). Augmented Reality has application in the field of learning (Di Serio, Á. et al., 2012). New possibilities for teaching and learning provided by AR have been increasingly

recognised by educational researchers (Wu, H.-K. et al., 2013). At the same time, research has indicated that AR systems and environments can help learners develop skills and knowledge that can be learned in other technology-enhanced learning environments, but in a more effective way (El Sayed, N.A.M. et al., 2011).

Adding augmented reality activities into e-learning require authoring tools that enable teachers to design the AR tasks and deliver them to the students. In previous studies, our research team has developed a stand-alone authoring tool that allows teachers to create and deliver AR activities (Hernández García, A.M., 2011). However, the proliferation in the use of LMSs at Spanish universities (Álvarez García, V.M. et al., 2012) suggests that teachers would greatly benefit from the integration of the authoring tool into the LMSs, thus complementing current e-learning systems, and contributing to the improvement of teaching methodologies and learning by providing a wider and richer range of learning activities for teachers and students.

2. RESEARCH PROPOSAL

Augmented reality authoring tools existing today (Jee, H.-K., 2011; Klopfer, E., 2002) are more related to digital content creation (Ha, T., 2010; Shin, M., 2005) than to the design of learning activities. These authoring tools are usually characterised by including the necessary functionality to design the interface to be visualised. The proliferation of these tools is limited and their use is not widespread.

Our research group has developed an augmented reality authoring tool named Ariane (http://www.pulso.uniovi.es/mobilelearning/ariane/), which allows teachers to design and deliver augmented reality activities, and students to download and interact with the activities from their mobile devices.

The aim of this research is to explore and address the use of authoring tools to support the design and delivery of AR educational activities, and the integration of the authoring tool into existing LMSs, such as Moodle, in such a way that the use of a different learning platform than the one currently used in the institution is not longer required. This research will be conducted on the most used LMSs at Spanish public universities (Álvarez García, V.M. et al., 2010), such as Moodle, Blackboard and Sakai.

The research methodology follows primarily a constructive research approach. Research activities related with this methodology include build, evaluate, theorise and justify. Nonetheless, some stages of this research have a more exploratory focus and hence they require a thoughtful review of the scientific literature on AR tools, AR activities, authoring tools, and their implications for the teaching-learning process. This study is aimed at providing us a global overview of the educational settings which are the most appropriate to implement AR activities, as well as a discussion on the proposed theories and models, both from an instructional design and technical perspectives, which are required to validate or refute our proposal.

Another outcome of the exploratory phase of this research consists in determining which activities must be managed by augmented reality authoring tools, and consequently, deciding the activities that will be integrated into the LMSs. In order to perform this study, we propose to search for indexed journal papers and relevant conference papers on augmented reality in education, as well as gathering information from teachers and students by means of surveys and questionnaires. One of the goals of the questionnaires is to detect lacks in the current teaching-learning process, and help to find solutions by means of using augmented reality technologies. Furthermore, surveys are also designed to facilitate teachers and students to detect and contribute in the selection of activities that are the most useful for their final implementation using educational augmented reality. Finally, the participants will be asked to try the Ariane's authoring tool, and determine its current possibilities in the educational realm as well as its expected value to different subjects.

Once the activities and their value are determined, we will explore the different modules and services currently provided by LMSs, and the best approach for allowing the integration of the augmented reality authoring tool into the LMSs. The development of prototypes is also covered in the constructive phase of the research methodology, which includes also the evaluation and collection of results to validate or refute our proposal. We will develop prototypes for all selected activities in the previous phase, and different approaches for allowing the integration into the e-learning platform will be tested, as an important factor for the selection of the best technical solution. The knowledge acquired during this research phase must enable us for determining the architecture of the solution and allowing us for the integration of new educational augmented reality features as needed. Latterly, the evaluation of the results obtained with teachers and the subjects of the study will enable us to determine the success of the approach proposed in this article.

Augmented reality activities will be added to the subjects conducted by teachers who decide to participate and collaborate on this research. Teachers and their students will be asked to rate the benefits of integrating augmented reality activities into LMSs. Two approaches will be used in order to rate the integration. On the one hand, surveys and interviews with teachers and students will allow us to provide a measure of the satisfaction as well as identify the strengths and weaknesses of the proposals. On the other hand, students's marks will be used as an indicator that allows us to rate the extent to which the proposed solution contributes to bring didactic effectiveness and improve learning.

3. CONCLUSIONS AND FUTURE WORK

Educational Augmented reality environments and systems can help learners to develop skills and knowledge that can also be learned in other technology-enhanced learning environments, but in a more effective and attractive way, enabling the exploration of the physical space. Adding augmented reality activities into e-learning require authoring tools that enable teachers to design the AR tasks and deliver them to the students. However, the proliferation of authoring tools is limited, and they are more focused on creating digital content rather than the design of learning activities.

In this paper, we propose a research aimed at exploring and addressing the use of authoring tools to support the design and delivery of AR educational activities, and the integration of the authoring tool into existing LMSs. In this way, the teacher does not need to use a different learning platform from the one currently used in the institution. From the student perspective, learners are encouraged to discover new learning activities they can perform as well as new ways of learning by means of interacting with the real environment.

We propose to conduct a prospective study on this subject in order to determine which augmented reality activities must be added to the teaching-learning process, the best manner to integrate them into existing LMSs, and evaluate the results obtained from testing educational augmented reality activities with teachers and students in experimental subjects. While AR offers new and exciting opportunities, it also creates new technological and pedagogical challenges that require researchers from different backgrounds and disciplines to collaborate interactively. A thorough evaluation of educational AR systems must consider, besides technical, pedagogical aspects, in order to determine the degree of completeness of the objectives and allow researchers to rate the extent to which the proposed solution contributes to bring didactic effectiveness and improve the teaching-learning process.

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ENHANCING MOBILE WORKING MEMORY TRAINING BY USING AFFECTIVE FEEDBACK

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ABSTRACT

The objective of this paper is to propose a novel approach to enhance working memory (WM) training for mobile devices by using information about the arousal level of a person. By the example of an adaptive *n*-back task, we combine methodologies from different disciplines to tackle this challenge: mobile learning, affective computing and cognitive psychology. Mobile applications for WM training offer the advantage that a user can perform a training session independently of time and location. Using approaches from affective computing, training sessions can be made more challenging and engaging by making them adaptive to the current state of a user. In contrast to conventional adaptive WM trainings, our approach uses physiological signals to extract information about the arousal level of a person. In this paper, we address the question how information about the arousal level of a user can be captured and how this information can be used to influence the overall learning procedure. An approach to integrate feedback about the arousal level of a person into mobile WM training is presented and exemplified using the *n*-back task.

KEYWORDS

Mobile learning, affective computing, psychophysiology, working memory.

1. INTRODUCTION

Within the last few years there has been a strong tendency of learning applications getting mobile. This requires rethinking of how learning applications are designed as learning performance may differ due to varying environmental conditions which cause the user to be in different affective states. Therefore, it is important to integrate affective information into mobile learning applications.

The concept of integrating information about user affect into learning environments is not new; it was first introduced by Picard (1995). Since then, much research has been done towards learning systems which consider affective information in a stationary learning environment (e.g. D'Mello et al., 2007).

We present an approach which uses innovative wearable sensor technologies integrated into a mobile learning environment. Using the example of the *n*-back task, we illustrate the practical use of such an affective mobile WM training and how it can help to improve the overall learning process. Not only can it help to get a more differentiated picture of the learning process but also to prevent users from being bored or frustrated due to too easy or too difficult tasks. Especially in a mobile environment, information about the emotional arousal of a user can help to incorporate changing environmental conditions. For instance, the difficulty at the beginning of the task can be adjusted to the current arousal level. Moreover, results of a task can be presented in relation to prior trainings where a user has been in a similar state.

This paper is organized as follows: section 2 describes the theoretical background of WM training and how physiological signals can be used to gather information about the arousal level of a person. After specifying the research questions in section 3, section 4 describes a research approach which integrates information about emotional arousal into a mobile WM training. In section 5, we describe how the proposed system can help to improve mobile learning experience.

2. THEORETICAL BACKGROUND

The term working memory refers to the ability to temporary store and process information for complex cognitive tasks at the same time (Baddeley, 1992). WM represents the ability to control attention (e.g. Engle, 2002) and its capacity is correlated with a large variety of higher-order cognitive tasks such as reading comprehension, complex learning and reasoning (Daneman & Carpenter, 1980). WM capacity decreases constantly with aging (e.g. Hale et al., 2011). Continuous training of WM can help to maintain cognitive abilities for a longer time. For younger adults, training of WM can help to improve performance in many areas. As a result, a large number of WM tasks and trainings have been developed. During WM tasks, information has to be kept in active memory while distracting or interfering activities are performed. Recent studies indicate that WM training which adapts the difficulty to the learning progress is more effective than training which does not adapt to the current state of a user (Klingberg et al., 2005; Schmiedek et al., 2010). However, these trainings adapt solely based on prior performance in the training task. The affective state of a person remains disregarded although the engagement of a person in the learning process has an important influence on the learning outcome. Presenting learning materials in an activating way keeps a person motivated and can help to maximize learning outcome (Dror, 2008).

Emotion and activation are accompanied by physiological arousal which is reflected in reactions like increased heart rate or skin conductance (Grandey, 2000). According to the Yerkes-Dodson-Law there exists an optimal arousal level for a high learning performance. While a very high arousal level can be advantageous in simple tasks, for difficult tasks it can cause a decrease in performance (Yerkes & Dodson, 1908). Therefore, it is crucial to detect the optimal arousal level during a task to achieve the best learning performance. Questionnaires and interviews are commonly used for this purpose. However, these traditional methods may fail when used in a mobile learning environment. For instance, Robinson & Clore (2002) found, that if the presentation time of a questionnaire is too far away from an event, answers underlie systematic biases. Moreover, data from questionnaires and interviews might not be honest and be influenced by subjective factors (Wali et al., 2009). In contrast to these methods, using physiological data can provide an objective measure of the affective state of a person as physiological signals are controlled by the central nervous system and are relatively resistant to manipulation. Additionally, physiological signals are constantly emitted which allows continuous monitoring of the user state. However, in mobile learning environments, physiological signals have to be recorded in an unobtrusive way that does not affect a person in his or her daily routine. New wearable sensor technologies can help towards this goal. Morris & Aguilera (2012) subsume the technical development of the last years: “Much of the wearable and environmental sensing that was considered futuristic only five years ago have become practical or at least easily imaginable tools for daily life”. This opens up new possibilities for ambulatory assessment of physiological data.

There has been a lot of research towards systems that are able to recognize arousal from physiological data. For instance Lichtenstein et al. (2008) achieved a recognition rate of 82% on a 5 point arousal scale using electrocardiogram (ECG), electrodermal activity (EDA), breathing rate, temperature and electromyographic (EMG) signals. Haag et al. (2004) achieved even higher recognition rates (89.73% on a continuous arousal scale with a bandwidth of 10%) with a neural network classifier using features extracted from ECG, EDA, skin temperature, blood volume pulse, EMG and respiration. In the following, we describe how arousal recognition from physiological signals can be combined with mobile learning applications.

3. RESEARCH QUESTIONS

As mentioned above, so far the adaption of the difficulty of WM tasks has solely been done based on prior task performance. The current state of a user remaines disregarded. Using information about a person’s arousal level to adapt task difficulty of a mobile WM training can bring major advantages:

- At the beginning of the training, task difficulty can be adapted to the current arousal level. Hence, training always starts at a challenging but not overstraining level and is therefore more effective.
- During the training, task difficulty can be decreased before a user is frustrated (e.g. due to high error rates) and increased before a user gets bored due to mental underload.
- Training results can be presented in relation to previous results when the user was in a similar state like at the time of the training.

The integration of arousal information into a mobile WM application raises the following research questions (RQ):

RQ1: *Which physiological sensors are suited best in order to unobtrusively derive feedback about the arousal level of a person in a mobile learning scenario?*

The major requirements for the selection of physiological signals are: (a) it has to be possible to record the signals continuously over a longer period in an unobtrusive manner, (b) the signal is highly corre-lated with arousal and (c) the signal quality has to be sufficient to extract arousal information online.

RQ2: *How can the information about the arousal level be integrated in a mobile learning application?*

The arousal information which is extracted from the sensor data has to be provided to the mobile learning application. A flexible solution which allows to easily exchange sensors or algorithms in the future is preferred for this purpose.

RQ3: *Which mechanisms can be developed to adapt the difficulty of a WM training?*

For the WM training it is crucial to find appropriate mechanisms how the training has to adapt according to different levels of arousal.

RQ4: *Can the learning outcomes really be improved by affective feedback?*

Integrating information about the arousal level derived from physiological signals into a mobile WM application is a novel approach. Thus, it has to be validated, how far this approach can help to increase effectiveness of the WM training.

4. RESEARCH APPROACH

In the following, we describe how physiological sensors can be used to extract information about the arousal level of a person and how this information can be integrated into a mobile WM training. Moreover, we illustrate how the WM application can adapt to the arousal level of a person and how effectiveness of such an application can be validated.

RQ1: ECG, EDA and eyeblink rate (EBR) are well known to correlate with the arousal level of a person and can be recorded noninvasively with unobtrusive wearable devices. Therefore, we decided to use these signals for our learning system to obtain information about the arousal level. Heart rate – derived from the ECG signal – reflects the activity of the sympathetic and the parasympathetic nervous system. While emotional arousal and stress cause heart rate to increase, relaxation decreases it (Berntson et al., 2007). EDA is a well-established parameter in psychophysiological studies about arousal. It has for instance been used for arousal classification by Healey & Picard (2005) and Reinhardt et al. (2012). EBR is also influenced by cognitive processes such as arousal. For instance, Oh et al. (2012) found an increase in EBR during the Stroop task. Moreover, Bentivoglio et al. (1997) found that EBR significantly increased during conversation while it decreased during reading. To record ECG and EDA we use the wearable ECG chest belt ekgMove and the EDA bracelet edaMove developed by movisens. Both sensors have been developed such that they can be worn over a longer period without disturbing a person in his or her daily routine. Moreover, the sensors can be placed such that the signal is relatively robust to movement artifacts. To gather information about EBR, we use the integrated camera of the mobile device on which the WM training is performed. Systems like EyeGuardian (Han et al., 2012) and EyePhone (Miluzzo et al., 2010) have successfully demonstrated that it is possible to detect eye blinks using the integrated camera of mobile devices. The algorithms used to extract information about the arousal level have to be very light-weight and have to be able to deal with small window-sizes as the results have to be provided online on the mobile device.

Preliminary results of a study where high and low arousal were induced in a laboratory setting indicate, that heart rate, heart rate variability and EDA amplitude are very well suited to differentiate between arousal levels.

RQ2: Integrating information about arousal into the affective learning application in real-time requires software which is able to extract the arousal information from the raw sensor data and to provide it to the learning application. Moreover, it should be possible to easily exchange components without making changes to the rest of the framework as new sensor devices and algorithms might become available in the near future. Therefore, we decided to use the xAffect software (Schaaff et al., 2012). xAffect is a modular middleware which has been developed as a solution to compute online biofeedback from physiological sensor data. A large number of components can be combined in order to obtain the desired setup for a specific application.

One great advantage of the modular design of the xAffect middleware is that it allows rapid prototyping. If new innovative sensor devices become available or new algorithms for arousal recognition are developed, the components currently implemented can easily be replaced or extended by the new components without making changes to the rest of the framework. For the current research, the ekgMove and the edaMove sensor as well as the integrated camera of the mobile device are integrated as data sources. Appropriate data processors to classify the arousal level of a person have to be implemented based on previous findings about arousal classification from other studies. The arousal level is computed by xAffect as a combination of features from all data sources. All recorded data can be logged for later analysis.

Figure 1. Design of the affective learning system

The xAffect software is integrated into the mobile learning application as a library. Figure 1 illustrates the elements of the affective mobile learning framework and their interplay.

RQ3: According to the arousal information, which the learning application receives from the xAffect software, the difficulty of the learning application can be adapted to the current arousal level of a person. It is important that the difficulty is always kept on a challenging but not overstraining level. There is a large variety of tasks for WM training. To make WM training adaptive, appropriate mechanisms have to be found. We use the *n*-back task as an example to demonstrate how WM training can be made adaptive to the arousal level of a user. In the *n*-back-task a sequence of stimuli is presented to the user and the user has to decide whether a stimulus matches the stimulus *n* steps earlier. There are several factors in the *n*-back task which can be used to vary task difficulty: presentation time, interstimulus interval and the number of items or the dimensionality of items for the spatial *n*-back task respectively. At the beginning of a training session the current arousal level of a person is used to determine the optimal complexity of how to start the training.

Currently, the adaptive *n*-back task is implemented as a desktop version. For the mobile WM training it will be transferred to a mobile system.

RQ4: The integration of arousal information into a mobile WM training is a novel approach. Thus, the effectiveness of the affective WM training has to be evaluated. For this purpose, the *n*-back task will be implemented in two versions: an adaptive version and a non-adaptive version which can be used to train a control group. In the validation study, the treatment group and the control group will use the WM training on a daily basis over a longer period of time. The study will be accompanied by questionnaires using a mobile experience sampling system. A second objective of the study will be to find out if motivation of participants is higher if changes in performance are computed in relation to training days where a person's arousal level has been similar to the one in a previous session. As WM performance varies systematically across days (Brose et al., 2012), this can help to obtain a more distinguished picture of the training success.

5. EXPECTED OUTCOME

With the current research we present an approach how affective information can be integrated into mobile learning devices. Methods from biosignal processing and affective computing are combined with a mobile learning application for WM training. The application will be able to adapt task difficulty based on the arousal level of a user. The arousal information will be extracted from physiological sensor data. We hypothesize that using this system the performance in WM tasks can be significantly improved in comparison to existing approaches as WM training is most effective when done at a challenging level. One limitation of the system is that additional sensors have to be worn to measure ECG and EDA. Future works will therefore include research towards even less obtrusive sensors to capture data. Moreover, additional environmental parameters captured by the mobile device – such as the current location of a user or the background noise – can be integrated in the adaptive process. Modulating the training difficulty to keep the arousal at an optimal level by using task and biofeedback based adaption mechanisms will help to maximize the learning outcome.

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